Communication and Collaboration

A Collaborative Approach to Community Wildfire Hazard Reduction

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Abstract—*This paper highlights the very successful collaborative approach to community wildfire hazard reduction being used in the 5 county NW Region of the Washington State Department of Natural Resources. NW Region cooperators have created a successful model to help affected communities reduce their risks to wildland fire. Identified high risk communities have been approached by a multi-agency team with Firewise education and hazard assessment methodology. Participating communities have received mini-Firewise workshops, community hazard assessments and hazard mitigation planning assistance. By working collaboratively with communities, local fire districts, County Conservation Districts, County Fire Marshal's Offices and Departments of Emergency Management, as well as other State and Federal fire managers, dramatic results in the Region have been achieved. The Firewise Communities/USA model has been used to guide communities through a nationally recognized process of risk assessment, mitigation planning and community specific outcome based solutions. Community fuels reduction efforts have focused on the creation of defensible space and shaded fuel breaks, reducing structural ignitability, as well as implementation of forest stewardship and greenbelt plans. Community recognition by the Firewise Communities/USA program is the measure of success.*

Introduction

The Washington State Department of Natural Resources (WADNR) is responsible for wildfire protection on 12.7 million acres of private and state forest land. While fire can play a beneficial role in the forest ecosystem, it can also be a destructive force that endangers our natural resources, our property, and even our lives.

In today's firefighting in rural and forested areas of the state, traditional boundaries between those fighting wildfires and those battling structural fires overlap giving way to the common need to help one another. The Wildland Urban Interface (WUI), where "the trees meet the eaves," is an area of great concern to the wildland fire fighting community. It is in this area, the WUI, that fire prevention and education activities can have a great positive impact.

By educating property owners and community groups on loss mitigation strategies in the WUI, fire managers from all agencies can influence positive changes in a very hazardous element of the fire ground (the WUI). It is this social change, the change from passive to active behaviors, that can create home sites and communities that are more resistant to loss or damage caused by wildfires. In addition, as property owners and communities become more educated, the dangers associated with firefighting in the WUI can be greatly

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diminished. Toward these efforts, the NW Region of the Washington Department of Natural Resources has embarked on a WUI wildfire education campaign that has been very successful.

The Northwest region of Washington Department of Natural Resources is located in northwest Washington State, west of the Cascade Crest and just south of the Canadian Border (Figure 1). It covers a 5 county area north of Seattle that includes Whatcom, Skagit, San Juan, Island and Snohomish counties. Puget Sound and the San Juan Islands add considerably to this region's diversity.

Risk Assessment

Using the Wildland Urban Interface Fire Hazard Assessment Methodology and risk assessment components from NFPA 299 (now NFPA 1144), the WADNR, NW Region conducted a systematic wildfire risk assessment. Recent census data was queried to identify potential WUI areas. These landscape areas were assessed for risk using a representative sample scored against NFPA 299 criteria. Hazard levels were identified and subsequently mapped using census polygons. The rating scale as defined by NFPA 299 was utilized resulting in hazard ranking from Low to Extreme (Figure 2).

**Figure 1**—Washington State Department of Natural Resources Regions
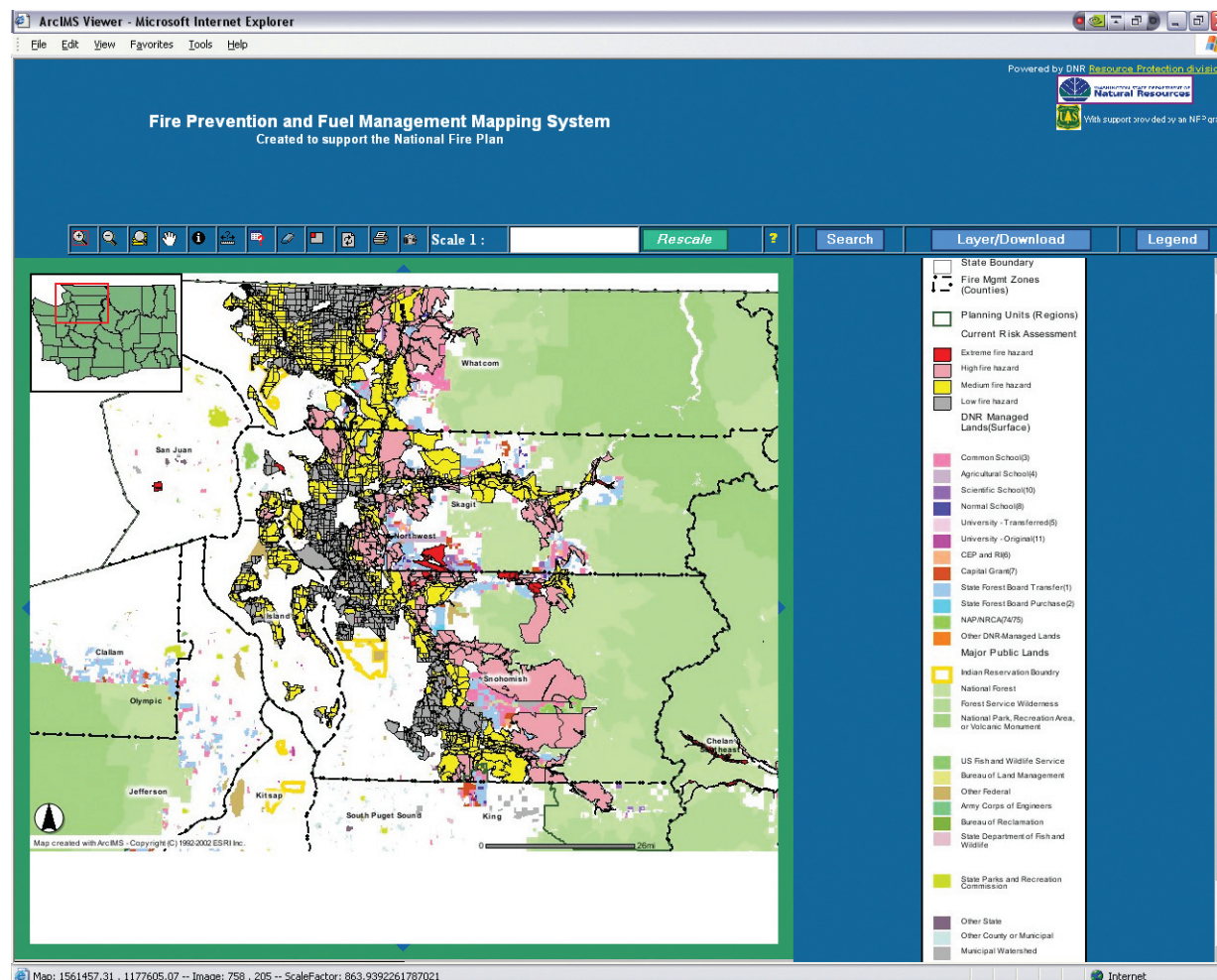
Figure 2—Risk Assessment. The first phase to identifying Landscapes of Similar Risk

Landscapes of Similar Risk

Under the Healthy Forests Initiative and the Healthy Forests Restoration Act (HFRA), the requirement to identify at-risk communities and conduct Community Wildfire Protection Planning (CWPP) was defined. Using guidance provided by the National Association of State Foresters, WADNR used its most recent Wildfire Risk Assessment to identify Landscapes of Similar Risk. Members of local fire management agencies assisted with this effort along with County Departments of Emergency Management, Fire Marshal's Offices and other local state and federal fire managers in the spring of 2004. They took the current regional risk assessment and consolidated risk assessment boundaries down to the landscape level. Landscapes risks were not restricted by county borders, therefore a true landscape was considered. These landscapes were named and digitized to create a GIS map layer (Figure 3).
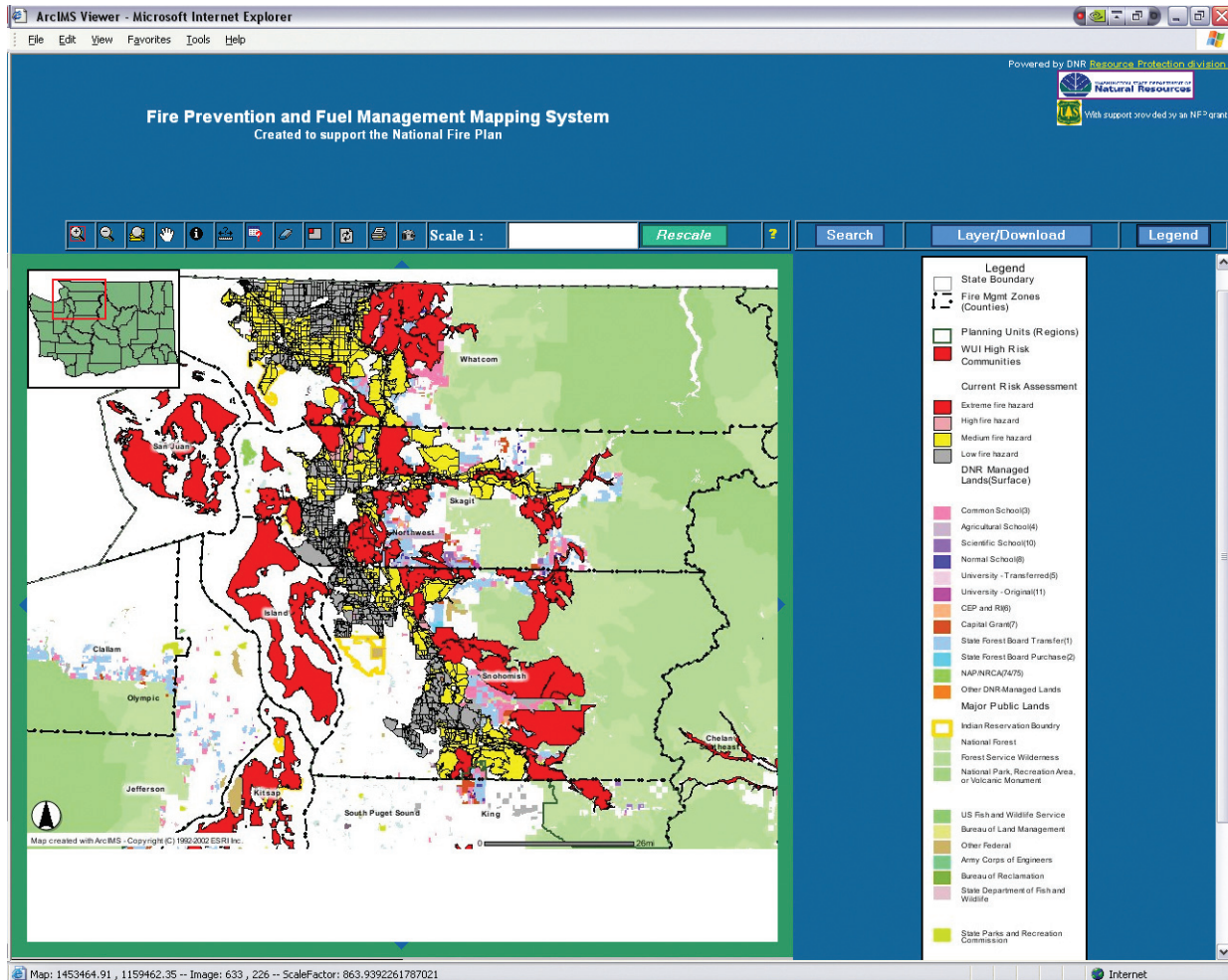
Figure 3—Landscapes of Similar Risk. Identified by regional fire managers through a collaborative process.

Prioritize With RAMS (Risk Assessment & Mitigation Strategies)

RAMS is a computer software program designed to systematically perform landscape level risk assessments (RA), prioritize landscapes and plan mitigation strategies (MS). Federal agencies, as well as WADNR, have adopted RAMS to prioritize, plan and track fire prevention activities. A component of RAMS is the communities' module. This module allowed us to perform a systematic assessment of our landscapes of similar risk using the following standard criteria:

- Fuels Hazard
- Ignition Risk
- Historical Fire Ignition
- Fire Return Interval
- Values, and
- Protection Capability

Inter-Agency Collaboration

A critical component of the National Fire Plan, as well as HFRA, is inter-agency cooperation. This component was also critical to the success of our WUI prevention & education program. Generally speaking, in Western Washington where catastrophic wildland fire incidents are not an every day occurrence, it is difficult to convince WUI residents that they have a fire problem. Residents have been more receptive to Firewise education when addressed by a multi-agency team of fire and education professionals.

In the WADNR NW Region, strong inter-agency relationships were created to facilitate the WUI Prevention & Education program. Partner agencies were identified based on concurrent agency missions. For example, the mission of the Skagit Conservation District is *to provide voluntary, incentive based options that support working landscapes while protecting and enhancing our natural resource land base*. This mission, along with the Skagit Conservation District's experience in community education and outreach make them an ideal collaborator. Funding and support from the local Skagit County government and Title III funds make it possible for the Conservation District to play a vital role in WUI prevention and education.

County Fire Marshal's Offices and Departments of Emergency Management are examples of other agencies whose missions align with the DNR in Community Wildfire Prevention efforts. Partnering with other Federal and State fire managers is important as well. The local fire department is the final key to a successful community wildfire prevention program.

With this multi-agency team, a strong, coordinated message can be delivered to WUI residents. It becomes very apparent to residents, when speaking with one voice, that there really is a fire problem. As understanding comes, residents are more receptive to mitigation strategies and an effective education campaign can begin.

Working With At-Risk Communities

Once the team is assembled and roles and responsibilities have been decided, steps to initiate contact with targeted at-risk communities can begin. There are two ways that contact is initiated between a community at risk and an agency representative. The agency can target a community they have determined is a priority for outreach efforts. In this situation the first and most important step is to get the community to recognize that there is an ignition risk and then take ownership for that risk. This is often the most difficult part of the education process, but is much easier with a multi-agency team. Another way is when the community initiates contact with the agency, seeking guidance in dealing with their fire problem. This situation circumvents the hurdle of getting the community to recognize and take ownership of their fire problem because at that point they have already done so. In either scenario, developing a relationship with, and an understanding of, the community is crucial to determining how to move forward in the process.

Initial stages of developing a relationship with a target community require an effort on the agency's part to understand the demographics of that community. This includes such factors as community size, community governance, resident lifestyles and any other characteristics of the community that play into its' abilities to respond to a wildfire issue. For example, a community that has

well established governance may be able to enforce a covenant that requires fire resistant roofing materials on new construction or any other Firewise type of practice; whereas a community without well established governance may not be able to enforce such a rule, they may only be able to suggest it. In cases like this, the agency representative would want to tailor outreach approaches in the community to reflect these concerns. Understanding the community and making the approach specific to that community will allow for a more successful result.

Community Leadership

Another important aspect of developing a relationship with a community is to identify a "community spark plug." This term refers to a member, or members, of the community who has taken on a leadership role or has the most interest and/or concern for the matter. The role the community spark plug fills is crucial to the dissemination of information in the community. This person is the front line contact for agency representatives to communicate with a community. They are an integral component of all WUI prevention programs. They could, for example, be the person who gets permission from the community board for the wildfire experts to do a presentation for the community. Having a member of the community take personal responsibility to bring forward the message and draw in other community members opens the door for further outreach opportunities. In a successful model, there will always be an individual or group of people who will emerge to fill this role.

The Workshop

In order to reach the community as a whole and disseminate information, it is best to host some sort of informational meeting or workshop (Figure 4). Whether the community solicits an agency for a presentation or vice versa, it is most effective to bring the presentation to the audience. Including the presentation as part of some other event that's already scheduled will be more effective because the audience is already there. For example, scheduling a presentation as part of a regularly attended board meeting won't require any extra time of the community members.

No matter what you call your meeting or workshop, there are some important aspects to consider. First, the community should be approached by a team of experts which should include but aren't limited to the local fire district, any wildfire and/or forestry experts that have jurisdiction in the area, and a county fire marshal or warden. A team of experts can provide informational presentations of all aspects of wildfire and can deliver a more powerful message than just one person representing one agency. This also allows for shared responsibility in communicating information to the community and allows for use of a wider range of resources. Even though the experts hosting the meeting may be federal or state representatives, the focus of the presentation should be local.

Using materials available at the Firewise website, a tailor-made presentation can be easily created. At a minimum, the workshop should address the community fire problem, information on what makes homes burn (structural ignitability) and information on mitigation strategies in the Home Ignition

Figure 4—Mini-Firewise Workshop.

Zone (the home and it's immediate surroundings). With this basic toolbox, property owners can, if they choose, begin to make an impact where the impact is needed, at the home. If the workshop can convince property owners that they can greatly reduce their homes potential ignitability, then we have begun the necessary paradigm shift. If property owners in the community begin to manage their home ignition zones and reduce structural ignitability then the community is well on its way to a better outcome when a wildfire does occur.

A good way to get the community to respond to a presentation and initiate follow-up contact is to offer free technical assistance. One way to do this is to offer home assessments where all homeowners that are interested receive individual attention and expert advice on their home ignition risk. Making it easy for the community to access these resources will result in a more positive and successful response. After the workshop, an introduction to the Firewise Communities/USA program can provide the process and motivation for a community to become firewise.

A Collaborative Approach to Community Wildfire Hazard Reduction: Shelter Bay Community Case Study

The community of Shelter Bay is located in western Washington, on Fidalgo Island in western Skagit County, just outside the small town of La Conner (Figure 5*)*. Fidalgo Island was identified by the Washington State Department of Natural Resources as a high-risk area for wildfire due to various physical characteristics of the landscape and the proximity of homes to the wildlands. The community consists of just over 900 lots, as well as greenbelt tracts, community beaches, and recreational areas (Figures 6 & 7*)*. Shelter Bay homes
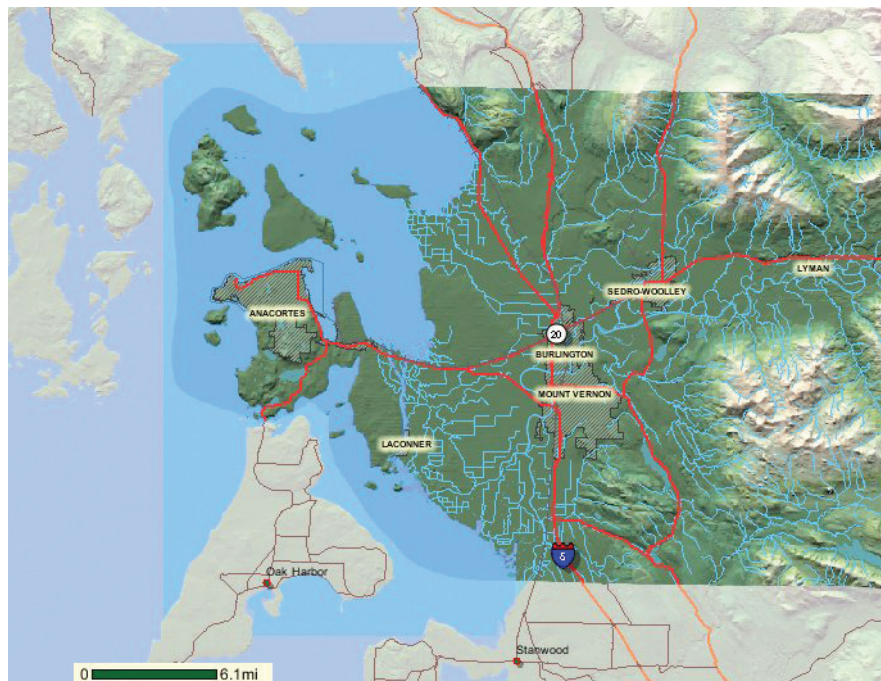
Figure 5—Shelter Bay is located just outside La Conner, WA.
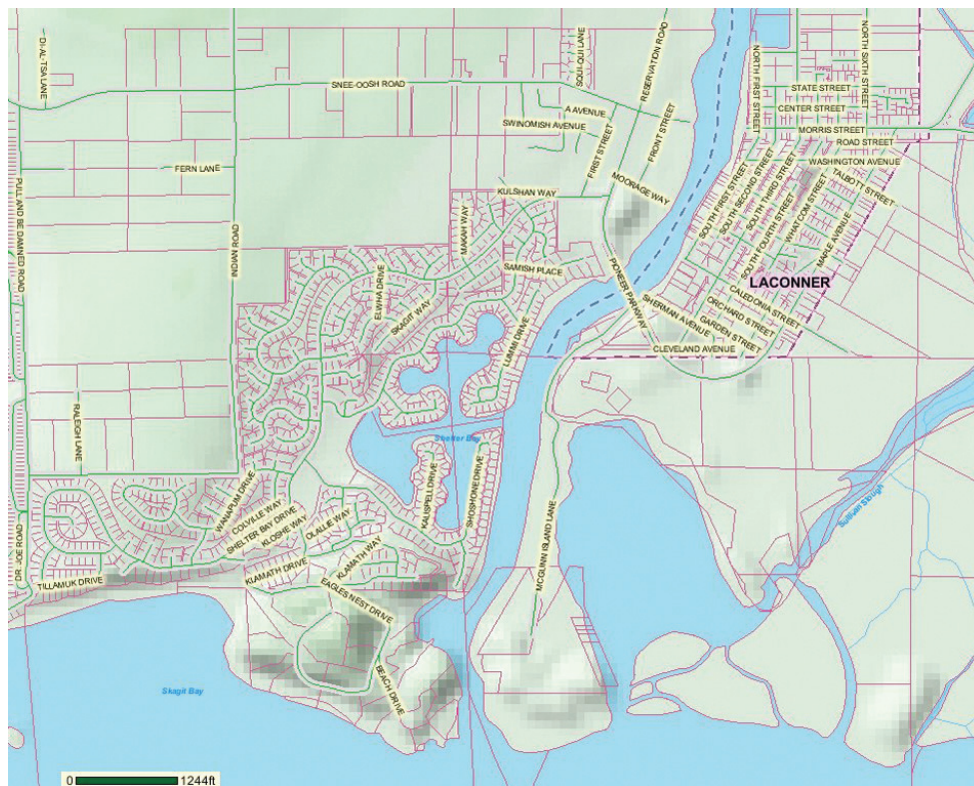

Figure 6—Shelter Bay Parcels.

Figure 7—Shelter Bay Aerial Photo.

and streets wind through a maze of steep and hilly topography. Interspersed throughout the homesites are varying acreages of designated greenbelt. These greenbelts make up approximately ¼ of the community's acreage. The greenbelts vary in their fuel models and range from grass and dense brush to heavy timber. Enough ladder fuels are present in the greenbelts to cause single-tree and group-tree torching that could result in ember showers on adjacent homes. Shelter Bay Community has well established governance that allows the management of community issues through the use of standing committees. For example, the greenbelt committee deals with management issues in the greenbelt such as views, pruning, thinning and tree topping. There are building and lot committees that handle issues with building and construction covenants, rights, and restrictions. When the Firewise committee was approved, it was appropriate that it become an ad hoc committee to provide advice to and interface with other committees in the community. The Firewise Committee is dedicated to reducing the ignition potential and increasing awareness of WUI issues in the community.

They contacted the wildfire experts in the region, including the Skagit Conservation District (SCD), the Washington State Department of Natural Resources (WADNR), and the Skagit County Department of Emergency Management/Fire Marshal's Office (DEM, FMO). Together these agencies are responsible for promoting the Firewise program throughout the county and the region. The stakeholders also included the Shelter Bay Community at large, the local fire chief and a Skagit County Commissioner. Once the community made contacts, the multi-agency team was able to guide the community in their actions.

It started with a Firewise presentation in conjunction with an already scheduled information session to answer questions about the ongoing use of the goats for greenbelt cleanup. The purpose of the presentation was to educate the community on the wildfire hazard and emphasize personal responsibility and defensible space regarding protection of private property. This presentation was developed and lead by SCD and DNR. Also present were the Skagit County Fire Marshal, the district fire chief, and one of the Skagit County Commissioners.

Each representative had a specific role and perspective to offer the community as well as specific resources for wildfire safety. The SCD was able to effectively communicate the idea of personal responsibility and mitigation strategies for around the home. The SCD took on the responsibility of being the direct line of communication to the community as a whole, as well as individual landowners in offering them technical assistance and free home assessments. The DNR was able to offer expertise in fire behavior and communicating the risk situation. The fire chief provided perspective on local fire fighting resources and current fire fighter capabilities. The fire marshal was able to provide a regulatory perspective, building code information and discuss outdoor burning regulations. The County Commissioner was there to offer support of the program, recognizing the importance of our/their efforts and provide encouragement. This approach not only allowed for all aspects of fire safety to be addressed in an initial presentation, but also as the community moves forward with their Firewise mitigation measures, this multi-agency team can offer a comprehensive set of resources to aid the community. Sixty-five community members attended the presentation. This collaboration continued and will continue to be an effective way of guiding the Shelter Bay Community through the Firewise process.

Once the relationships between agency representatives and the community were established, the multi-agency team was able to assist the community with moving forward in their pursuit of Firewise actions. This began with a Community Hazard Assessment for the Shelter Bay Community. The hazard assessment addressed the various aspects of wildfire hazards throughout the community on a community-wide scale. These hazards were analyzed and addressed with a final recommendation of creating an action plan to establish mitigation measures.

From here, the residents that had become active and interested in the Firewise process formed an ad-hoc Firewise Committee of 11 members in order to follow through with an action plan and pursue projects, as well as national recognition through the Firewise Communities/USA program. As the community had already completed a major project in reducing the fuels in their greenbelts, they were already well on their way to meeting the requirements of becoming a recognized Firewise Community. Their second project (currently under way) is a Firewise demonstration landscape. The community picked one highly visible area of greenbelt as their project site. Between the Conservation District and the WADNR, the site was evaluated and a planting design was created that met the objectives of the community: Firewise, wildlife habitat enhancement. Currently a final plan is being developed that addresses these goals and objectives as well as the planting design and plant list, and provides resources on such aspects of the project as proper planting methods and proper pruning techniques etc. Once this project is established, the community hopes to use it as an education tool. They also hope to pursue further Firewise planting projects within the other greenbelt areas.

As these ideas developed, so did the need for additional community organization. With the guidance of the Conservation District and the WADNR, the Firewise Committee is currently working on developing a comprehensive five-year action plan for their community. This action plan will be included as part of the community's comprehensive emergency management plan. Also, as part of the requirements of being a Firewise Community, they are planning a Firewise education event at the end of April where they will showcase their Firewise demonstration planting area and invite the community to celebrate their Firewise Communities/USA recognition status.

As the Shelter Bay community continues to build upon their first years' accomplishments, momentum continues to build as well. Their most recent accomplishment was a covenant change to prohibit the use of cedar shake roofs on all new construction (& re-roofing projects where greater than 50% of the roof is replaced), opting to support more fire resistant roofing materials to be used. This represents a major accomplishment and a significant understanding of the wildland fire problem in the community. As the committee finalizes the 5-year action plan, it is assured that their success will continue.

Shelter Bay Community was recognized as a Firewise Community/USA for the year 2005. Requirements of 2006 recognition will be met by May 2006.

Firewise Communities/USA

The Firewise Communities/USA is a recognition program designed and maintained to give communities the maximum flexibility in creating outcome based site specific solutions to identified wildfire hazards. Briefly the program involves:

- Enlist a wildland/urban interface specialist to complete a community assessment and assist with the creation of a plan that identifies achievable solutions to be implemented by the community.
- Form a Firewise Committee which promotes and maintains the FWC/USA program and monitors and reports progress.
- Observe a Firewise Day annually that is dedicated to a community Firewise project or education event.
- Invest a minimum of $2.00 per capita on community Firewise Projects
- Submit an application that documents compliance with recognition requirements and renew annually to maintain status.

It provides community members with the knowledge necessary to maintain an acceptable level of fire readiness, while ensuring firefighter safety during a wildland fire emergency. The program draws on a community's spirit, its resolve, and its willingness to take responsibility for its ignition potential.

By implementing the FWC/USA as described, it truly becomes a self-perpetuating program. All of the training, education and tools for a community to take action are provided. Ongoing support by the multi-agency team is needed, but becomes less and less time consuming the more a community learns. Support activities will always be necessary, but the community leadership is always at the forefront. The local fire department needs to stay engaged as the resident expert on emergency management, but this is a good relationship to foster as it provides a solid link between the community and Emergency Management Services.

Conclusion

Wildfire incidents do not have to be large, nor span many days to be catastrophic. Losing just one home in the Wildland Urban Interface becomes a significant, life changing problem for those involved. It has been shown that with proper preparation, a home does not have to become fuel for a wildland fire. Reducing structural ignitability by focusing on the home ignition zone is the easiest way for homeowners to mitigate wildfire hazards in their community. Every home that has been prepared in this way has a much greater chance of surviving a wildland fire incident. After all, a home that doesn't ignite is a home that doesn't burn.

The NW Region of Washington State Department of Natural Resources, in keeping with our agency mission and mandate, embarked on a collaborative WUI wildfire education campaign that has been very successful. After using national standards to identify at-risk communities, the FWC/USA program was utilized to engage community groups. It is a model that allows agency interaction with the greatest number of communities at a time. With proper preparation and a collaborative environment, fire management agencies can greatly impact communities in the WUI, thereby creating behavioral changes designed to mitigate losses in communites due to a catastrophic wildland fire event. NW Region has been a leader in implementation of FWC/USA in Washington state and has contributed to Washington's 2005 #2 ranking in the nation of recognized communities (Figure 8*).*

Success has been largely due to excellent inter-governmental and inter-agency relationships, a shared vision and the desire to succeed. The collaborative environment has been achieved through hard work and committment of all parties and continues to be a model that other areas of the state and the nation are striving to emulate.

Figure 8—Firewise Communities/USA Sites.

Organizational Characteristics that Contribute to Success in Engaging the Public to Accomplish Fuels Management at the Wilderness/Non-Wilderness Interface

Katie Knotek[1] and Alan E. Watson[2]

Abstract—*In the fall of 2003, the Rocky Mountain Ranger District of the Lewis and Clark National Forest initiated a multi-year, large-scale prescribed burn in the Scapegoat Wilderness. The objectives of this burn were to make the non-wilderness side of the wilderness boundary more defensible from wildfire and to establish conditions that will allow fire to play a more natural role within the wilderness in the future. Using this prescribed burn as a case study, qualitative research was conducted in 2005 to understand the local ranger district's public outreach efforts and its subsequent influence on public attitudes towards the burn. A series of in-depth interviews with agency personnel involved in the burn, and representatives from local communities who were aware of and/or participated in public outreach efforts for the burn, were the primary sources of data for this research. A framework of mindfulness processes exhibited by high reliability organizations was used in analysis for identification and understanding of organizational characteristics that contribute to success in engaging the public in Forest Service efforts to treat hazardous fuels and manage risk from wildfire. As a case study, the methods and results provide a means of comparison to additional cases on other management units.*

Introduction

Fire suppression policy on public lands over the past century has resulted in hazardous accumulations of fuel in forest and grass lands. In many places, fire is a naturally occurring process, and fire exclusion has spurred greater incidents of large-scale, uncharacteristic wildfire impacting both ecological and social values across the wilderness/non-wilderness interface. The urgency, complexity, and oftentimes contentious nature of fire and fuels management operations have signaled the need for increased public outreach (public information and involvement efforts) by wildland fire management organizations. The public must be informed about and engaged in decisions concerning appropriate fuels management techniques to reduce the risk of catastrophic fire and restore the health of our wild lands (HFI 2002; USDA/USDI 2000).

Along the Rocky Mountain Front in northwestern Montana, public land protected under federal designation as the Bob Marshall Wilderness Complex (includes the Bob Marshall, Scapegoat, and Great Bear Wilderness areas) interfaces with public and private lands comprising roadless areas, ranches, outfitter/guide operations, recreational residences and other human uses. There is a rich history of naturally occurring fires in the Bob Marshall Wilderness Complex, although years of fire suppression has reduced the number of acres burned by these fires and created conditions for uncharacteristic fire behavior. In an effort to allow fire to play a more natural role within the

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wilderness and to make the non-wilderness side of the wilderness boundary more defensible from wildfire, the Rocky Mountain Ranger District of the Lewis and Clark National Forest initiated, in the fall of 2003, the first phase of a multi-year prescribed burn inside and along the boundary of the Scape-goat Wilderness. The complex ownership and human uses surrounding this area exemplifies the importance and need for mindful management of public outreach concerning such a large-scale fuels management project.

In their book, *Managing the Unexpected: Assuring High Performance in an Age of Complexity*, Weick and Sutcliffe (2001) outline a theory of managing high-risk operations with mindfulness. Their research on managing mindfully draws upon the concept of high reliability organizations (HROs). They suggest businesses or other organizations "benchmark on the experts in reliability" in managing for unexpected events, offering "techniques that are worth copying because they ensure faster learning, more alert sensing, and better relationships with customers" (p. xv).

It may be appropriate to apply concepts of high reliability to an organization's management of public outreach, because managing the interaction between an organization and the public also involves managing the unexpected. Many unexpected events can occur when managing public outreach: contentious public meetings; withdrawal of key publics from participation; harassment of personnel within the organization; negative editorial or opinion pieces in reference to the organization; and litigation. To reduce the likelihood of such events occurring, an organization needs some framework to guide their management of public outreach.

Using the South Fork of the Sun River Prescribed Burn as a case study, we applied Weick and Sutcliffe's theory on managing with mindfulness to the USDA Forest Service's (USFS) management of public outreach for the prescribed burn. A framework of mindfulness processes was used as a guide to document and analyze the organization's public outreach during the planning and implementation stages of the prescribed burn and how it influenced local community attitudes. This research can increase understanding of organizational characteristics that contribute to success or failure in engaging the public to accomplish fuels management at the wilderness/non-wilderness interface.

Research Framework

Research on high reliability indicates there are five central processes that produce mindful behavior within high-risk organizations, including: 1) recognizing potential barriers to accomplishment of management objectives (preoccupation with failure), 2) resisting simplification of information or interpretations (reluctance to simplify interpretations), 3) ensuring situational awareness of events as they occur (sensitivity to operations), 4) being prepared to respond to and recover from unexpected events (commitment to resilience), and 5) calling upon appropriate expertise in decision-making and management efforts (deference to expertise) (adapted from Weick and Sutcliffe 2001). These five attributes are believed to be the hallmarks of HROs and managing with mindfulness.

Research on managing with mindfulness has typically focused on interaction within an organization (i.e., wildland firefighting, nuclear aircraft carriers, air traffic control systems, and emergency medical treatment) without necessarily considering interaction that occurs external to an organization such as public outreach. It is important to understand how mindfulness can be applied to the management of external, as well as internal interaction,

because it is often this interaction that people use to evaluate and respond to a particular organization and their management capabilities. Using a framework of mindfulness processes to analyze the USFS's management of external interaction (public outreach) should provide new insight into the value of managing with mindfulness.

Methods

A case study research design and qualitative methods (in-depth interviews) were used to facilitate the research and provide a deeper understanding of the contribution of the USFS's mindfulness in managing public outreach for the South Fork of the Sun River Prescribed Burn. Interviews were conducted with a sample of agency representatives on the Lewis and Clark National Forest and non-agency public representatives from local communities surrounding the Rocky Mountain Ranger District.

Interviews were guided by a pre-arranged set of themes and suggested lead-in questions, using a semi-structured interview guide, but they did not follow a fixed question format (Patterson and Williams 2002). All interviews were tape-recorded in their entirety, transcribed verbatim, and kept anonymous. Analysis began, following completion of the transcriptions. Each transcript was edited by simultaneously listening to the associated tape-recording and reading the text. The final edited transcripts were the empirical data that were analyzed using a qualitative data analysis software program, QSR Nvivo version 2.0.

In a case study research design, a previously developed theory is used as a template for analysis of the study findings (Yin 1989). A framework of mindfulness processes was used to guide analysis of agency and public representatives' perceptions of public outreach for the prescribed burn. Analysis emphasized objective description and personal interpretation by the researcher with a focus on organizing data to best document the phenomenon of interest within the specific case (Denzin and Lincoln 1998).

Results

A total of 14 agency representatives (both past and present) from the Lewis and Clark National Forest were individually interviewed. Interviews were conducted with personnel who had, in some way, been involved with the planning and implementation (including public outreach) of the South Fork of the Sun River Prescribed Burn. In order to get a diversity of perspectives, the intent was to conduct interviews with personnel representing different functional positions within the agency. Thus, interviews were conducted with personnel in the following positions: decision-making (line officers); planning; public affairs; information; fire; recreation; and wilderness.

A total of 24 non-agency public representatives from local communities surrounding the Rocky Mountain Ranger District were interviewed. Interviews were conducted with people who were aware of and/or participated in public outreach activities (i.e., attended public meetings, submitted public comment, read newspaper articles, received informational mailings, etc.) for the prescribed burn. To obtain a diversity of perspectives, interviews were conducted with people with varied social resources and interests. Thus, interviews

were conducted with private landowners, outfitter/guides, representatives from cooperating city, county and state organizations, representatives from non-governmental organizations, media personnel, local recreationists, and recreation residence owners.

The database of interview transcripts serves as empirical evidence for claims or conclusions drawn in this Results section, which contains excerpts of raw text from interviews that correspond to specific subject headings. Detailed below are a select set of these interview excerpts, which serve as examples of public outreach efforts by the agency that seemed to be indicative of the five central processes of mindfulness.

Recognizing Barriers to Accomplishment of Management Objectives

Being consistently mindful of potential barriers to accomplishing management objectives, although suggestive of a negative mindset, is actually a positive behavior that can benefit an organization. Being mindful of potential operational failures or mistakes makes it possible for an organization to identify and mitigate small barriers that, if ignored, could complicate or jeopardize their objectives (adapted from Weick and Sutcliffe 2001). Perceptions of both agency and public representatives indicated personnel on the Lewis and Clark National Forest demonstrated this mindfulness process in managing public outreach during the planning and implementation stages of the prescribed burn.

Agency representatives felt that agency personnel made personal one-on-one contacts with landowners who had the greatest potential to be impacted by the prescribed burn should it escape. These landowners happened to also be outfitters in the local area preparing their camps for the upcoming hunting season. The agency's decision to contact these members of the public was symbolic of its ability to manage mindfully, for the agency saw the potential for damage to private property and human resources, and the possible barrier it could create to accomplishment of management objectives before an escaped burn occurred:

> **Interviewer**: *And how come it was those two resorts that you went to?*

> **Agency Representative**: *Because they are the ones in the vicinity that would be the ones that would be the most rapidly impacted if something went wrong with that fire … it was in the early fall, and so both of those resorts have backcountry camps and they were going in and out of their camps at that time, getting them ready for the hunting season. So they had even more stake in the whole scenario, because they had people actually in the backcountry hauling hay or doing that kind of thing, and so we needed to coordinate with them on those types of things so that we made sure that if their packers were on their way out we weren't going to have a problem.*

There was also evidence from perceptions of public representatives that agency personnel demonstrated an awareness of potential barriers to its management objectives by engaging the public early on in the planning of the prescribed burn. This early outreach, which included contact with the local media, allowed the public to be informed about project details from the very beginning and reduced the likelihood of them being "blindsided" by the agency's intentions:

Public Representative: *But from my perspective, I thought what they did worked well, partly because they did it in advance. A lot of times people say, and this was a big criticism during the Canyon Creek Fire, we just didn't know what was coming. We just didn't really, we underestimated. We didn't know. You didn't tell us, etc. … I don't think anybody could fault them. Like you said, this started in '97. It happened in 2003. That's a long time and a lot of comment before the actual trees started to burn. So I think they did a good job … I don't know what else they could have done to get information out to people. And I think Augusta's a relatively small community, I think they probably had close to saturation knowledge of what was going on.*

Resisting Simplification of Information or Interpretations

In the modern world, success is often achieved when a person simplifies work by focusing on key issues or problems; in contrast, managing with mindfulness means resisting simplification of information or interpretations. When practicing this tenet of mindfulness, organizations intentionally simplify less and seek ways to perceive and discern more about their management situation, creating a more holistic, detailed understanding of the context they are working within (adapted from Weick and Sutcliffe 2001). It was evident from perceptions of both agency and public representatives that, during the planning and implementation stages of the prescribed burn, personnel on the Lewis and Clark National Forest demonstrated this mindfulness process in managing public outreach.

There was a perception among agency representatives that agency personnel made an effort to talk about the known risks of the project rather than glaze over them or hide their significance when interacting with the public. This effort to communicate directly with the public about the risks associated with the prescribed burn seemed to be an indicator of the agency's resistance to simplify information or interpretations related to public outreach. Here's what one agency representative said he or she would do in the future when dealing with similar fuels management projects and outreach to local communities:

Agency Representative: *I'd follow the same model, and I would also be, and I believe we did this this time, I would also be frank about the risks … and by that I mean we have all these checks in process to be as safe as possible. And sometimes things are going to go south on us. And that happens. The fire could get out of our control, and we know that. And put that on the table early on in the process, not in terms of sugar coating. And (the District Ranger) did a good job of that. (The District Ranger) was very real. So, actually that's a good take-home message for other people, other units, other agencies. Sometimes we're not very good about talking about the real risks.*

Perceptions of public representatives indicated the agency resisted simplification of information or interpretations in managing public outreach, also, by addressing public concerns about the Canyon Creek Fire of 1988 (a wildland fire that escaped the Scapegoat Wilderness boundary) and how it related to the prescribed burn. As suggested in the excerpt below, it would have been easy for agency personnel to avoid this issue in order to simplify their communication with the public, but they chose to speak to the issue and to communicate their plans to prevent a similar occurrence:

Public Representative: *… I keep coming back to '88 … clearly an event happened there that the Augusta community got exposed to. And, again, superficially that was something that it would have been easy to shy away from, and (the Fire Management Officer) didn't do that. (The Fire Management Officer) says we want to avoid that. And that's to say (the Fire Management Officer) took that experience, took that event, and presented it to the community saying we're with you, we recognize this is something that's not very fun to go through. It can be devastating to go through. And we think we have an idea to, if not prevent it, then potentially minimize it at the very least. And so with using that circumstance, it would have been easy just to stay away from, just to put a big veneer lacquer around it and just say, uh, that was a bad deal and just never go there again. But they didn't do that. They said let's take that and run with it or let's respond to that. And so bringing in that history, I think, was a good part of it.*

Ensuring Situational Awareness of Events as They Occur

There is a tendency for people to be forward thinking, but mindfulness requires personnel within an organization to display intense focus on what is happening in the present. Organizations that manage with mindfulness focus their attention on the front line of an operation, ensuring situational awareness of events (both planned and unexpected) as they occur. By paying attention to events as they unfold, these organizations are more able to reduce uncertainty and make operational adjustments as needed (adapted from Weick and Sutcliffe 2001). Again, there were perceptions of both agency and public representatives that indicated personnel on the Lewis and Clark National Forest demonstrated this mindfulness process in managing public outreach during the planning and implementation stages of the prescribed burn.

Agency representatives perceived that a big part of the USFS's engagement with the public prior to implementation of the burn was through briefings with key segments of the public, such as county commissioners, the governor's staff, and the media. Sensitivity to the information needs of these publics during the planning process and a willingness to engage in public dialogue about the project are an example of organizational efforts to ensure situational awareness in managing public outreach:

Agency Representative: *The District Ranger was very proactive. I must compliment him on that, because he was very proactive in getting community involvement … he developed a PowerPoint and he went around to various organizations. He talked to his county commissioners. We set up a series of briefings for him. He briefed the governor's staff. He talked to the county commissioners from Lewis and Clark County, which is where Augusta is. He also talked to Teton County commissioners, which is where Choteau is … He talked to TV stations. He did radio call-in interviews with KGPR and the local station that's in Augusta, KMON. That's the station that most people could hear … We've only briefed the governor on two or three issues the whole time that I've been here, and this is one that we thought would be critical in case we did lose it.*

Public representatives perceived several other examples, which suggest agency personnel maintained situational awareness in managing public outreach. The agency's use of press releases and newspaper articles, making documents available for public review, providing informational handouts, and holding public meetings, all seemed to have helped keep the public informed and involved in the planning process and the agency aware of public interest and concern related to the project:

> **Public Representative**: *They were putting out press releases. They had obviously done studies, and they had those documents out for public review. And they had, I want to say that they had information available in the Augusta Information Station if people wanted to come in and get fact sheets on it. They had their personnel available at any time for people to call ... They weren't just touching the Choteau Acantha as media, they were also, there were stories being published in the Great Falls Tribune, and I am almost certain that there were stories published in the Helena newspaper, although I didn't ever read any of those. But I think they were trying to reach as many people as they could. Particularly with this project, it seemed to me that they made a really big effort to do a really good job in informing people about what was going on.*

Being Prepared to Respond to and Recover from Unexpected Events

The fourth mindfulness process can be described as being prepared to respond to and recover from unexpected events that occur. Managing with mindfulness means moving beyond a simple anticipation of unexpected events to a greater focus on how, once an unexpected event occurs, an organization and its employees can respond to and/or recover from the event. This resiliency enables organizations to function responsively and facilitate management even when faced with operational obstacles (adapted from Weick and Sutcliffe 2001). In interviews with agency representatives, several examples were identified where it seemed as though personnel on the Lewis and Clark National Forest were prepared to respond to and recover from unexpected events when managing public outreach during the planning and implementation stages of the burn. These examples were easily identifiable in the analysis of the data because agency representatives were giving firsthand accounts of being prepared to respond to and recover from unexpected events that occurred.

For example, when the agency decided it was time to implement the prescribed burn, they realized that the Public Affairs Officer for the Forest was scheduled to be on a business trip to Washington, DC. As perceived by agency representatives, knowing that this position was crucial to public outreach during the burn, the agency seemed prepared to respond to this unexpected event by finding a qualified replacement to fill this position, an employee within the region with experience in both public relations and fire:

> **Agency Representative**: *And then when it came actually time to burn it, it was so frustrating because we didn't think we were going to have a window in the fall. And when the burning window opened up it was the same week we had scheduled, they were going to burn on whatever day they ignited the burn, I don't remember if it was Monday or Tuesday, but the Forest*

> *Supervisor and the Forest Planner and (the Forest Public Affairs Officer) were flying out to Washington, DC, because we had briefings with our senators and congressmen … so we had to call in other people. And (an employee) from the Regional Office came over and actually took the media out, because we had planned field trips for the media to be on a lookout to see the actual ignition of the burn and to watch the progress of it the first day.*

In the analysis of data from interviews with public representatives, examples in which the agency appeared prepared to respond to and recover from unexpected events were not as easily identifiable. Thus, there were no obvious interview excerpts from public representatives that can be used to demonstrate that the agency was prepared to respond to and recover from unexpected events when managing public outreach during the planning and implementation of the burn. There are a couple of possible explanations for this occurrence.

First, it might be possible that the public didn't perceive the unexpected events the agency was challenged with during planning and implementation and their resiliency in responding to them. This may be especially true in this case where several unexpected events occurred and were dealt with internally rather than publicly (i.e., having to fill in for the Public Affairs Officer while in Washington, DC). Also, the fact that agency personnel *were* resilient in responding to these unexpected events, may itself have made it more difficult for the public to perceive such behavior.

Calling Upon Expertise in Decision-Making and Management Efforts

The final mindfulness process is calling upon appropriate expertise in decision-making and management efforts. Unlike a rigid hierarchy where decisions are imposed from the top down, when incorporating mindfulness into decisions and operations, personnel with the most expertise, regardless of their position within the organization, are utilized. This does not preclude the fact that certain decisions must be made and operations led by personnel in specific positions (adapted from Weick and Sutcliffe 2001). As indicated from perceptions of both agency and public representatives, it seemed evident that personnel on the Lewis and Clark National Forest often called upon appropriate expertise in decision-making and management efforts related to public outreach for the prescribed burn.

One key indicator that the agency called upon appropriate expertise in decision-making and management efforts was the fact that local agency personnel were charged with the planning and implementation of the burn, including public outreach. Even though an Incident Management Team was brought in to assist in burn operations, agency representatives perceived that local personnel on the District were largely in charge of leading the multifaceted operation:

> **Agency Representative**: … *we identified that at the beginning that we're going to help reduce risk by having a (Incident Management) team involved. But one of the major points, debates about that with the public was that we want you guys involved. You're not going to hand this over to a team, right? Oh, no, no. You know, our Burn Boss was still (a District employee), who's right here out of Choteau. Our ignition specialist in the air was*

> *(a District employee), our FMO (Fire Management Officer).*
> *Our ground ignition specialist was (a District employee), our*
> *AFMO (Assistant Fire Management Officer). And then (the*
> *District Ranger would) be there as the line officer making the*
> *calls for the Forest Supervisor in terms of whether we would*
> *ignite that day or not. And (he'd) be the one dealing with the*
> *people, heading up public meetings, talking to the media …*

It was also evident from public representatives that the agency called upon appropriate expertise (in this case local expertise) in their management efforts, including the Fire Management Officer, District Ranger, and Burn Boss, who are all employees of the Rocky Mountain Ranger District and members of the local communities, Augusta and Choteau. Public representatives, similar to agency representatives, talked about the importance of the agency utilizing the local expertise of these individuals, people well known in the local communities, in planning and implementing this specific project:

> **Public Representative**: *I think that they demonstrated to*
> *people that the local Forest Service personnel, like (the Fire*
> *Management Officer), (the Burn Boss), (the District Ranger),*
> *that they were local faces that were well-known that were going*
> *to be connected to this burn and that they were very credible*
> *and responsible and accountable. And I think people sensed*
> *that, that there was going to be an enormous amount of local*
> *accountability for this burn. And I think because of that some*
> *people probably felt that their concerns were expressed or reduced*
> *because it wasn't going to be some nameless face for a federal*
> *project. It was going to be the responsibility of people that you*
> *could look in the eye and talk with … You're my neighbor and*
> *I know you.*

Perceptions of Changes in Community Attitudes Towards the Burn

Through analysis, agency and public perceptions of changes in local community attitudes towards the burn were identified, as well as perceptions about whether the agency's management of public outreach had influenced these attitudes. Public representatives had mixed thoughts on whether or not local community attitudes had changed during the project. Some thought negative attitudes among local community members hadn't changed and never would change. There was also a perception that, for the most part, community members had become ambivalent towards the burn, knowing the agency was actively moving forward with the project. There was however, some evidence from public representatives that attitudes *were* influenced during project planning and implementation, in particular becoming more positive or accepting and supportive of the burn.

Agency representatives also had mixed thoughts on whether or not community attitudes had changed. Similar to public representatives, some agency representatives thought community attitudes toward the burn had become more positive, while others thought there had been no change. For those who thought community attitudes had changed, there was some indication that the agency's evident mindfulness in managing public outreach had influenced these attitudes. For example, there was some belief that the agency's openness in public meetings and one-on-one contacts, demonstrating situational awareness in managing public outreach, had an influence on community

attitudes towards the burn. Thus, agency representatives provided additional evidence of some attitude change during the project that can be attributed, in part, to the agency's mindful management of public outreach.

Conclusions

This research offers an example of how a framework of mindfulness processes can be appropriately used to describe an organization's management of public outreach. The use of qualitative methods (in-depth interviews) allowed both agency and public representatives to openly talk about the agency's public outreach during the planning and implementation stages of the prescribed burn. Agency and public representatives discussed at length such things as public meetings, newspaper articles, one-on-one contacts with private landowners, briefing to key publics (county commissioners, governor's staff, media), and other such efforts detailed in the Results section, utilized by the agency in public outreach. Through analysis of the interview transcripts it was possible to not only identify but to also categorize and describe these outreach efforts by the agency as being indicative of the five central mindfulness processes (i.e., recognizing potential barriers to accomplishment of management objectives, resisting simplification of information or interpretations, ensuring situational awareness of events as they occur, responding to and recovering from unexpected events, and calling upon appropriate expertise in decision-making and management efforts). There was only one instance (public perceptions of the agency's ability to respond to and recover from unexpected events) where this was not possible.

Because use of the framework made it possible to analyze agency and public perceptions concerning the USFS's management of public outreach for the South Fork of the Sun River Prescribed Burn, this application of Weick and Sutcliffe's management theory seems to be effective at least to guide analysis. The USFS itself will have to determine the usefulness and effectiveness of this theoretical application as a management tool.

It is possible that the USFS and other wildland fire management organizations could use this framework of mindfulness processes as sort of a "checklist" before, during, and following public outreach to evaluate their management efforts. They could use the framework as a brainstorming tool when planning public outreach efforts. For example, they might individually, or as a group, proactively think about how they might be mindful of potential barriers to accomplishment of their management objectives, or how they might help to ensure situational awareness in managing public outreach. They could use the framework while they are actively conducting public outreach activities to incrementally evaluate individual and group behavior as it relates to the management of public outreach. For example, they might critique their efforts to resist simplification of information or interpretations related to public outreach, or their ability to respond to and recover from unexpected events that have or might occur. They could also use the framework following public outreach efforts to evaluate and learn from their efforts in a fashion similar to an After-Action Review. For example, they might discuss examples of where it seemed they had been exhibiting mindfulness processes, or examples of where it seemed they hadn't exhibited mindfulness processes and could improve upon their efforts in the future.

Finally, in using the framework of mindfulness processes to facilitate group discussion about public outreach efforts, it might be possible to identify

where contrasting perceptions about individual or group behavior exist among personnel within a wildland fire management organization. Such uses of this framework of mindfulness processes would likely help to improve understanding and practice of organizational characteristics that contribute to success in engaging the public to accomplish fuels management at the wilderness/non-wilderness interface.

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Communicating the Wildland Fire Message: Influences on Knowledge and Attitude Change in Two Case Studies

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Abstract—Current wildland fire policy calls for citizen involvement in planning and management. To be effective in their efforts to engage outside stakeholders, resource professionals need to understand citizens' understanding and attitudes toward current practices as well as how to best communicate about proposed actions. A variety of outreach methods have been used to communicate the rationale behind fuel reduction techniques. Limited evaluation of these efforts has occurred resulting in a lack of information available to guide the outreach decisions of agency personnel. This paper evaluates the effects of two basic communication strategies—unidirectional information exchange and interactive approaches—on participant understanding and attitudes. Data was collected in two phases; first, citizens completed a survey on-site prior to outreach participation, then, a follow-up questionnaire was mailed to each participant two weeks following initial contact. Resulting data enable assessment of the influence of outreach activities on participant understanding and attitudes and evaluation of factors that contributed to program success. Findings suggest interactive outreach methods may be more effective at influencing knowledge. However, unidirectional and interactive approaches influenced participants with low initial understanding of fire management or less supportive attitudes toward fuel practices. Results also showed a strong association between knowledge and attitude change suggesting fire professionals have a real opportunity to help shape public perceptions about appropriate management actions.

Introduction

Recent federal initiatives such as the National Fire Plan and Healthy Forests Restoration Act require a new approach to fire management. These policies emphasize two primary themes. First, there is an increased focus on using fuel reduction activities (such as prescribed fire or mechanized thinning) prior to a fire event to decrease the vegetation available to burn as fuel if a fire occurs. Second, both initiatives call for, and in some cases require, collaboration with stakeholders (including local citizens) in planning and prioritizing fire and fuel management activities. Natural resource communicators, including federal and state agency personnel, county extension agents, and interpretive staff, play an essential role in accomplishing these objectives.

Substantial research over the last several years has indicated the necessary role of social acceptability in resource management activities (see review in Shindler and others 2002) and specifically in fuel reduction efforts (Shindler and Toman 2003, Winter and others 2002). Accordingly, many management units are moving towards greater citizen involvement in the development and implementation of fire and fuel management strategies. To be successful,

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resource professionals need to understand citizens' knowledge of and attitudes toward current practices as well as how to best communicate with local communities about proposed actions. Outreach activities, as the primary interface between resource agencies and citizens, play an essential role in these efforts (Bright and Manfredo 1997).

In recent years, resource agencies have used a variety of methods to communicate the rationale behind fuel reduction techniques. Approaches have ranged from traditional text and graphic displays, such as brochures and exhibits, to more targeted activities, including demonstration areas and guided field tours. To date, limited evaluation of these efforts has occurred resulting in a lack of available information to guide the outreach decisions of resource professionals. The purpose of this paper is to fill this research gap by exploring the influence of two basic communication strategies—unidirectional information exchange and interactive approaches—on participant understanding and attitudes.

Related Research

Research on the social aspects of fire management has increased steadily in recent years. A review of the literature suggests a number of findings relevant to this study. First, research over nearly three decades has identified a positive association between fire-related knowledge and treatment support among citizens (e.g., Stankey 1976, Carpenter and others 1986, Shindler and Toman 2003). This finding has prompted researchers to call for increasing fire-related outreach activities to raise public awareness and support (e.g., McCool and Stankey 1986, Carpenter and others 1986). However, public acceptance is a complex issue and is not based solely upon technical understanding. Support for fire management is particularly influenced by the interactions between citizens and resource managers over time and reflects citizen confidence in agencies to effectively manage risk as well as provide an adequate planning process that includes a role for the public (Winter and others 2002, Shindler and Toman 2003). Ultimately, understanding is a strong precursor to support, but not sufficient on its own.

Second, public understanding and acceptance of fuel treatments have increased over time. Early research found that participants generally overestimated the negative impacts of fire while underestimating fire's beneficial effects (Stankey 1976). Not surprisingly, a majority preferred complete fire suppression. Subsequent research has consistently identified an upward trend in citizen understanding of key fire management principles and acceptance of manager-ignited prescribed fire (e.g., Carpenter and others 1986) as well as thinning for fuel reduction (Loomis and others 2001, Shindler and Toman 2003). However, Manfredo and others (1990) cautioned that the identified increases may only be occurring in particular geographic regions, specifically those areas most affected by fire, and may not be representative of general attitudes. Brunson and Shindler (2004) also found variations in understanding and support among locations and cautioned against implementing "one-size-fits-all" management or communication approaches.

Third, and particularly relevant to our study, fire-related outreach activities can positively influence participant knowledge and, in some cases, attitudes. Prior studies have evaluated response change following exposure to various communication activities (brochures, slide shows, workshops, etc.). Such activities can be classified as interactive or unidirectional based on the type

of outreach experience they provide. Interactive activities (including guided visits to demonstration sites and agency workshops) allow for two-way communication with resource professionals while unidirectional methods (such as brochures, public service announcements, and static displays) consist of a one-way flow of information. Toman and others (2006) suggest that interactive programs may be more consistent with principles of adult learning by relating information to the local context, incorporating citizen experiences and concerns, and providing greater opportunities to develop personal relationships between citizens and agency personnel. This project provides an opportunity to further test these ideas.

A review of prior research suggests that both unidirectional and interactive activities have achieved some success. For example, brochures have been effective at increasing knowledge (Taylor and Daniel 1984) and leading to more supportive attitudes (Loomis and others 2001). Nielsen and Buchanan (1986) evaluated a unidirectional (slide show) and an interactive activity (interpreter guided walk); both of which resulted in higher knowledge and attitude scores among participants. Marynowski and Jacobson (1999) report outcomes for an ecosystem management education program that targeted fire ecology as one of four content areas. The program consisted of various unidirectional communication methods including posters, brochures, youth activity booklets, and multiple news releases. These educational materials significantly increased knowledge of fire ecology, but did not result in a corresponding increase in support for fire management activities.

Recent research has increasingly emphasized interactive activities. For example, Parkinson and others (2003) evaluated the influence of workshops on attitudes and knowledge. The workshops consisted of hands-on activities adapted from FireWorks, an education program originally developed by the USDA Rocky Mountain Research Station to target middle school students. Following the workshop, participants experienced an increase in knowledge and more supportive attitudes toward fire management. Another study evaluated the influence of visits to sites treated by prescribed fire (Toman and others 2004). In a self-assessment, a majority indicated that prescribed fire was more acceptable to them as a result of having observed treated sites.

Finally, in a recent evaluation of a multi-faceted information program that used both unidirectional (brochures, mass media) and interactive methods (personal contact, group presentations, neighborhood meetings), McCaffrey (2004) found that personal contact contributed substantially to communication success. Indeed, educational materials, including unidirectional items, were more effective if delivered via personal contact. Findings suggest workshops, site visits, and other interactive activities may not only offer a means for information provision but also provide an opportunity for meaningful interaction with citizens.

Methods

Two study sites were selected; Sequoia and King's Canyon National Parks (SEKI) and the World Forestry Center (WFC). SEKI is comprised of adjacent parks located in the Sierra Nevada Mountains in central California. The parks have an active fuel management program that emphasizes management-ignited prescribed fires and managing naturally ignited fires to achieve resource objectives. Thinning, though less prevalent, is also used near structures to reduce fuel levels.

A broad range of outreach activities are represented at SEKI, including both unidirectional and interactive methods. Upon entering the park, all visitors receive a multi-page newsletter with details about park resources and facilities as well as general interpretive information. Within SEKI there are five visitor centers, each containing various interpretive activities including brochures, film strips, and static displays. Among these, the Giant Forest Museum offers a different, more sophisticated visitor experience than the other centers. Following recent renovation the Museum now provides a broad range of interactive and unidirectional activities, many of which emphasize the role of fire in the Sequoia lifecycle. National Park Service interpretive personnel are highly visible at the Museum and frequently engage visitors. Other outreach activities within SEKI include interpreter and self-guided walks and evening "naturalist talks" at the primary park campgrounds.

Given that visitors to SEKI were potentially exposed to both unidirectional and interactive communication methods, their responses provide an opportunity to assess the influence of communication type. In the follow-up questionnaire, respondents from SEKI indicated the specific programs they participated in while at the parks. Each activity was classified as interactive or unidirectional. Interactive programs included conversations with agency personnel, guided interpretive walks, evening naturalist programs, and visits to the Giant Forest Museum; all others were unidirectional.

The WFC is located in Portland, Oregon. From May through December 2003 the center presented "Fire: Forces of Nature." Each aspect of the exhibit was unidirectional and included photographs and text descriptions, examples of fire suppression equipment, videos on home protection and Smokey Bear, as well as an abridged version of the Nova film "Fire Wars" in the center's theater. The displays provided information about the use of prescribed fire and thinning to reduce fire risk. Overall, the exhibit represented a series of traditional formats that resource agency personnel could use to provide interpretive information at visitor kiosks, information centers, or state and county fairs. Although these formats are still largely unidirectional, recent technological advances have substantially increased the ability of outreach personnel to create high quality, visually appealing displays.

Data Collection

Data were collected in two phases. In the first phase, visitors were contacted and completed a brief questionnaire on-site before exposure to outreach activities. The on-site questionnaire included measures of citizen awareness and attitudes toward fuel treatments before soliciting respondents' contact information and agreement to participate in the follow-up survey. The follow-up was mailed to respondents two weeks following their initial contact. The delayed test was used to assess the enduring effects of exposure to outreach activities and control for experimenter expectancy effects (Leeming and others 1993). A primary benefit of the pre-test/post-test design is the collection of panel data, responses by the same individuals to the same measures at different points in time. Responses from individual participants can be "paired," or linked, over the separate data collection points to identify shifts in individual attitudes and beliefs.

Questionnaire design was informed by semi-structured interviews with agency personnel and project partners. Two questionnaires were developed, one for the on-site survey and another for the follow-up phase. The follow-up questionnaires replicated on-site questions while soliciting further information on awareness, attitudes, and understanding of fuel treatments, evaluations

of the outreach activities, and demographic information. Resulting data enable assessment of *between* and *within*-site differences as well as contributory factors. Follow-up mailings were conducted using a modified version of the "total design method" (Dillman 1978); surveys were sent in three waves beginning approximately two weeks following on-site contact.

Sample sizes and response rates are displayed in Table 1. As might be expected, overall visitation levels differ greatly between SEKI and the WFC. These differences are reflected in substantially different sample sizes between the two sites. Where comparisons are made between locations, chi-square tests are used. Because the test is based on the proportion rather than the number of responses, the chi-square statistic is robust to differences in sample size (Cohen and Lea 2004). The remainder of the comparative analysis is based on responses from participants within each location. Thus, the differing sample sizes have little influence on findings reported here.

Results

Respondents were similar demographically (age, education, gender, urban-rural residence) between locations. Overall, respondents had a mean age of 49 and were well educated; two-thirds (66%) had a bachelor's degree or higher. Just under half (44%) were women. Two-thirds (66%) lived in an urban area, while 34% came from a rural community.

Geographic Variation

Knowledge—To gauge citizen knowledge specific to fire and fuel management, respondents completed a five-item true/false quiz about treatment objectives and potential effects. Item development was based upon prior studies (Stankey 1976, Cortner and others 1984, Loomis and others 2001, Shindler and Toman 2003). Respondents appeared relatively knowledgeable with a majority answering each question correctly (Table 2). Indeed, participants' average initial score was 76% at SEKI and 82% at the WFC.

Chi-square tests indicate a few differences in responses between study locations. Specifically, in the on-site surveys, fewer SEKI respondents understood the role of fires in shaping natural forests or the impact of fires on wildlife. Interestingly, in the follow-up survey significantly more SEKI respondents correctly indicated that prescribed fires effectively reduce the amount of fuel in forests.

Table 1—Sample sizes and response rate.

	On-site sample size*	Post-surveys received	Response rate
World Forestry Center (WFC)	92	68	74%
Sequoia and King's Canyon National Parks (SEKI)	395	269	68%
Total	653	459	70%

* Represents number who completed the on-site questionnaire and provided valid mailing addresses.

Table 2—*Between*-site differences in response to quiz questions measuring knowledge about fire management issues.

| | | Percent of respondents | | | | |
	Location	Generally true	Generally false	Not sure	X²	Significance
Wildfires have played a significant role in shaping natural forests in the western United States.						
On-site	SEKI	*87*[a]	3	10	7.9	.019
	WFC	*99*	2	0		
Follow-up	SEKI	*93*	2	6	2.0	.361
	WFC	*97*	2	2		
Wildfires usually result in the death of the majority of animals in the area.						
On-site	SEKI	12	*66*	22	6.3	.042
	WFC	3	*79*	18		
Follow-up	SEKI	9	*71*	20	2.0	.361
	WFC	7	*79*	13		
Prescribed fire or controlled burns effectively reduce amounts of fuel in most forests.						
On-site	SEKI	*70*	9	21	1.6	.447
	WFC	*77*	4	19		
Follow-up	SEKI	*90*	2	8	7.8	.019
	WFC	*78*	6	16		
Prescribed fires or controlled burns reduce the chance of high-intensity wildfire.						
On-site	SEKI	*89*	3	9	3.6	.162
	WFC	*91*	6	3		
Follow-up	SEKI	*91*	3	6	.19	.906
	WFC	*90*	3	7		
A history of suppressing wildfires has increased the risk of a destructive fire in the western United States.						
On-site	SEKI	*68*	10	23	.54	.762
	WFC	*69*	12	19		
Follow-up	SEKI	*75*	8	18	2.5	.277
	WFC	*84*	4	12		

[a]The most correct responses are indicated by italics.

Attitudes—Participants also responded to a series of five statements regarding their attitudes toward fire management issues (Table 3). The first four items were based on prior research (Stankey 1976, Loomis and others 2001, Shindler and Toman 2003). The final item about thinning was included because previous studies suggest citizens may be concerned that thinning is simply an attempt to increase timber harvests on public lands (Shindler and others 2002, Shindler and Toman 2003). Results here indicate considerable uncertainty (don't know responses) about thinning activities even following exposure to outreach activities.

Overall, on-site responses were positive toward fire management, indicating a generally high level of support for treatments initially. There were no differences between SEKI and WFC on-site responses; however, agreement with management burning of underbrush differed in follow-up responses. While statistically significant, these differences have relatively minor implications for fire managers; in both cases a strong majority support periodic burning.

Changes Within Locations

Knowledge and Attitude Indices—A primary objective of this study was to examine the influence of participation in outreach activities on knowledge and attitudes. To assess change in understanding we created an index based on *within*-site participant performance on knowledge questions (responses presented in Table 2). A correct answer was coded as 1 while incorrect and "not

Table 3—*Between*-site differences in responses to belief statements measuring attitudes toward fire management issues.

	Location	Agree	Disagree	Don't know	X²	Significance
		Percent of respondents				
All fires, regardless of origin, should be put out as soon as possible.						
On-site	SEKI	16	78	6	2.4	.295
	WFC	9	85	6		
Follow-up	SEKI	3	93	4	1.3	.511
	WFC	6	90	4		
Managers should periodically burn underbrush and forest debris.						
On-site	SEKI	84	3	13	1.4	.494
	WFC	82	6	12		
Follow-up	SEKI	86	2	13	7.1	.027
	WFC	82	8	10		
Prescribed fires or controlled burns are too dangerous to be used.						
On-site	SEKI	5	83	12	1.8	.393
	WFC	6	88	6		
Follow-up	SEKI	2	93	5	4.7	.091
	WFC	6	85	9		
Prescribed fire or controlled burns should not be used because of potential health problems from smoke.						
On-site	SEKI	6	81	14	.16	.920
	WFC	4	82	13		
Follow-up	SEKI	3	86	12	.77	.678
	WFC	5	82	13		
Thinning for fuel reduction will lead to unnecessary harvesting.						
On-site	SEKI	15	51	34	2.7	.253
	WFC	19	57	24		
Follow-up	SEKI	18	55	27	1.2	.538
	WFC	21	59	21		

sure" responses were coded as 0; scores were then summed. Each participant received a score from 0 to 5. Using paired t-tests, on-site and follow-up indices were compared (Table 4). Mean knowledge scores significantly increased among SEKI participants, while scores at the WFC remained similar.

An index was also created for attitude scores based on responses presented in Table 3. Each variable was recoded with a response of 1 indicating a positive attitude toward fire management and 0 indicating either a negative attitude

Table 4—Within location changes—Knowledge and attitude indices.

	Mean response	
	SEKI	**WFC**
Knowledge index		
On-site	3.81	4.10
Follow-up	4.21	4.26
t-statistic	5.864	1.120
Significance	<.001	.267
Attitude index		
On-site	3.78	3.98
Follow-up	4.11	4.04
t-statistic	4.446	.414
Significance	<.001	.680

or don't know response; responses were then summed. Each respondent received an index score from 0 to 5 for the five attitudinal statements. As with the knowledge indices, the WFC scores remained similar throughout the study period while attitudes toward fire management improved significantly at SEKI.

Trends in individual change—Comparisons of mean index scores indicate whether an aggregate change occurred among the sample at each location, but do not provide an assessment of changes experienced by individual participants. To explore such changes we created two new variables, knowledge and attitude change, by pairing index ratings across the study period and subtracting the on-site from the follow-up scores. Thus, if a respondent answered two questions correctly in the pre-test and four on the post-test, their knowledge change would be two. These variables provide a measurement of change for each study participant.

The knowledge and attitude change variables revealed two important points (Table 5). First, preliminary observation suggested that respondents who showed the greatest amount of change were those with the lowest initial scores. To quantify this apparent difference, we used a t-test to compare the mean change between respondents with low (0-3) versus high (4-5) initial index scores. Mean change was significantly greater among those with lower initial index ratings. Specifically, respondents with low initial understanding or support were significantly more likely to experience positive shifts in knowledge or attitude following exposure to outreach activities.

Second, a substantial number of respondents in each location experienced a positive shift (increase of one or greater in index scores). At SEKI, 39% of respondents improved their performance on quiz questions and over one-third had more supportive attitudes following participation in outreach activities. Although slightly lower at the WFC, still more than 30% of respondents demonstrated higher knowledge and attitude scores in the follow-up.

Table 5—Within location changes—Trends in participant change.

	Mean response	
	SEKI	WFC
Knowledge change[a]		
Low initial knowledge group mean change[b]	1.16	1
High initial knowledge group mean change[c]	−0.01	−0.1
t-statistic	8.32	2.70
Significance	<.001	0.01
Percent of respondents with positive knowledge change following outreach participation	39%	31%
Attitude change[a]		
Low initial attitudes group mean change[b]	1.44	1
High initial attitudes group mean change[c]	−0.12	−0.31
t-statistic	9.29	4.78
Significance	<.001	<.001
Percent of respondents with positive attitude change following outreach participation	34%	32%

[a] Change was calculated by pairing responses and subtracting pre-test from post-test scores.
[b] Initial index score was 0-3.
[c] Initial index score was 4-5.

Factors Influencing Change

The number of outreach activities available at SEKI provides an opportunity for further exploration of the influence of program and participant characteristics on responses. Of particular interest is the influence that type of outreach experience (interactive or unidirectional) has on knowledge and attitude change. Certain SEKI activities (conversations with agency personnel, guided interpretive tours, evening naturalist programs, and visits to the Giant Forest Museum) were coded as interactive; all others (park newsletter, brochures, other visitor centers, and self guided trails) were treated as unidirectional. Each respondent then received a score based on their participation in interactive activities. Scores ranged from 0 (for no interactive experiences) to 4 (for participation in each interactive activity).

We then created two multiple linear regression models to assess the relative influence of respondent and program characteristics on knowledge and attitude change (see Table 6). Independent variables in both models include demographics (gender, age, education, urban-rural residence), individual relevance of fire topic (as measured by amount of prior thought given to wildfire), and participation in interactive activities. Because our findings suggest initial knowledge and attitudes may influence participant change, each model also includes the appropriate on-site index (e.g., the on-site knowledge index is included in the knowledge change model and the on-site attitude index in the attitude change model). Lastly, the models also included knowledge or attitude variable.

F-test results indicate that both models are statistically significant. Furthermore, each explains at least half of the variance in participant change as indicated by the R-squared statistics. Among the four demographic variables, gender and age significantly influenced knowledge change, while age and education had significant impacts on attitude change. Males and younger participants were more likely to increase in knowledge; older individuals and those with lower education levels were more likely to experience an attitude shift. Interestingly, despite prior research that has identified differences between urban and rural residents (Brunson and Steel 1996), residence type did not influence change in either model. Personal relevance of wildfires had

Table 6—Regression models testing influence of variables on knowledge change and attitude change at SEKI.

	Knowledge change		Attitude change	
	Standardized coefficient	Significance	Standardized coefficient	Significance
Gender (males = 1, females = 2)	–.140	.007	–.059	.240
Age	–.120	.020	.136	.007
Education	.080	.132	–.167	.001
Urban-rural residence	–.013	.800	–.041	.412
Relevance of fire topic	.173	.001	.102	.047
Participation in interactive activities	.134	.007	.045	.361
On-site knowledge index	–.702	<.001	—	—
Attitude change	.133	.011	—	—
On-site attitude index	—	—	–.692	<.001
Knowledge change	—	—	.106	.039
F-statistic	26.844	<.001	28.673	<.001
Adjusted R squared	.500		.518	

a significant effect; in both models, those who had previously thought more about wildfire were more likely to experience positive change.

Participation in interactive outreach activities significantly contributed to knowledge change; however, a corresponding influence on attitudes was not recorded. In both models, the variables with the largest influence on participant change were initial knowledge or attitudes (as measured by the on-site indices); standardized coefficients were −.702 and −.692 for on-site knowledge and attitude indices respectively. The negative coefficients reflect that respondents with low initial knowledge or attitudes were significantly more likely to experience a positive increase throughout the study period. Findings here demonstrate a significant association between knowledge and attitudes even when accounting for the influence of other variables; participants who experienced an increase in knowledge were also significantly more likely to experience a positive change in attitude.

Discussion

Recent policy directives require substantial public participation in developing fire management strategies. Successful participation depends upon the ability of resource professionals to communicate relevant information via effective outreach methods. Findings presented here provide information about participant understanding of and attitudes toward fire management, track changes following outreach participation, and assess factors that contribute to knowledge and attitude change. Several important points emerge from this study.

First, participants had relatively high knowledge and supportive attitudes before exposure to outreach activities. In many cases, responses were more positive than had been recorded in prior studies (Cortner and others 1984, Loomis and others 2001, Shindler and Toman 2001). While the research approach targeted individuals who generally may be more experienced with natural resource issues than the public at large (e.g., they chose to spend their leisure time at a natural resource site), the increase in scores over prior studies were substantial, even when compared with research that targeted wilderness visitors (Stankey 1976, McCool and Stankey 1986). Overall, responses here show a greater appreciation for the role of fire, as well as an increasing recognition of the consequences of fire suppression and the beneficial outcomes of the use of prescribed fire.

Likely contributors include recent agency emphasis on outreach promoting fire and fuel management as well as media coverage that has increased in both volume and depth. In particular, while media stories still highlight dramatic fire events, there has been increased attention paid to the factors contributing to fire activity (e.g., long-term fire suppression resulting in increased fuel loads) as well as potential responses by management agencies. Results here suggest this increased exposure has resulted in higher initial awareness of fire and a basic acceptance of some fire management practices among the general public. The management implication is that outreach activities and messages will need to become more sophisticated to continue to be relevant to an increasingly knowledgeable public.

Second, despite high levels of understanding and support, there appeared to be some uncertainty about thinning treatments. While previous research has found substantial support for thinning in some forest communities (Shindler and Toman 2003, Brunson and Shindler 2004), citizens have also expressed

reservations with thinning treatments as a new means to conduct "business as usual" and increase timber harvests on public lands (Shindler and others 2002). Indeed, much of the discussion in the popular press regarding the Healthy Forest Restoration Act has focused on whether the legislation would facilitate removal of large, mature trees (for example see McCarthy and others 2003, New York Times Editorial Desk 2003). Findings here suggest greater discussion within communities will likely be necessary before proceeding with large-scale thinning projects. Outreach activities can play an important role here, particularly interactive programs, as research has shown that personal contact can reduce the controversy surrounding thinning decisions (McCaffrey 2004).

Third, although prior research has suggested differences in citizen perspectives among locations (Manfredo and others 1990, Brunson and Shindler 2004), findings here were generally similar across study sites. This may partly be an artifact of our research approach. Specifically, contacting individuals at a recreation site (outside of their community) and not at their residence potentially reduces the influence of local contextual factors on citizen responses. That is, they may have responded to questions about fuel treatments in general rather than thinking about a prescribed burn near their back yard. It is important to note that while there appears to be good understanding and high support for the concept of fuel management practices, gaining acceptance among local residents for specific treatments will require more than general interpretive messages. The implementation of specific projects will require effective communication tailored to ecological and social issues at the local, and perhaps the neighborhood, level (Brunson and Shindler 2004).

Lastly, the data presented here demonstrate that outreach activities can positively influence citizen understanding and support. While only SEKI responses demonstrated an aggregate increase, approximately one-third of participants at both locations experienced some positive change throughout the study period. These program effects are particularly remarkable given the high initial scores as participant change is less likely when knowledge or attitudes are already well-developed (Dillard and Peck 2000). Results further reveal that participants with low initial knowledge or less positive attitudes were more likely to experience improvements across the study period. This trend was evident in both locations; even though there was not an increase in aggregate scores at the WFC, those with low initial scores were positively influenced. Importantly, populations with low understanding or less supportive attitudes are a key target audience of agency personnel and results here suggest they are likely to benefit the most from outreach activities.

Factors Influencing Change

A primary objective of these case studies was to assess factors that contribute to knowledge and attitude change. Of particular interest is the influence of interactive versus unidirectional outreach activities on participant responses. *Within*-location changes show that SEKI participants (exposed to interactive formats) experienced a significant improvement in knowledge and attitudes while the WFC responses (following a unidirectional experience) remained similar throughout the study period. While suggestive, these results may be confounded by additional variables. For example, SEKI responses were initially lower, albeit slightly, and these individuals may have been more susceptible to change. In addition, most SEKI respondents participated in multiple outreach activities; thus, knowledge and attitude changes may be influenced by greater exposure to fire-related information.

The regression models also provide mixed evidence. While participation in interactive activities positively influenced knowledge change, results provide no evidence of a corresponding impact on attitudes. Ultimately, findings here are suggestive but inconclusive on the influence of interactive outreach experiences. Our inability to identify potential effects may be a consequence of the measures used in this study. We replicated measures used by others, but the high initial performance may indicate it is time to increase the level of sophistication in our tests. A different set of knowledge and attitude measures may be necessary to identify change and assess contributory factors among an increasingly informed public.

Regression findings also provide information on additional influencing factors among SEKI respondents. Demographic variables had mixed effects; influences were either inconsistent or contradictory between the models. Thus, findings do not suggest a particular portion of the population to target through communication activities. Personal relevance of fire management had positive effects on knowledge and attitude change. The implication here is that residents in the wildland urban interface are prime candidates for outreach programs and messages will likely be more successful when crafted to demonstrate their application to local issues of concern.

Also noteworthy is the strong association between knowledge and attitude change. While substantial research has identified a correlation between knowledge and support for fire management activities (e.g., McCool and Stankey 1986, Carpenter and others 1986, Shindler and Toman 2003), such associations are not evident for all natural resource issues. For example, attitudes toward clearcutting are unlikely to change simply on the basis of new information (Bliss 2000). The consistency of these findings over time suggests that outreach activities may have a greater influence on support toward fire than other management issues. Accordingly, resource professionals may see greater dividends by focusing their outreach efforts to communicate the fire and fuel message.

Conclusion

Effective communication is essential to building the understanding and support necessary for sustainable resource management. Findings here suggest two basic levels of communication are useful. One is general information dispersal; this usually involves broad messages that can be conveyed by unidirectional, mass communication formats such as newspapers, brochures and public service announcements. Messages delivered through this format are typically created for general public consumption and, as such, provide few opportunities to target specific audiences. Because it is difficult to ensure that information is received and understood, their effectiveness as an educational tool is limited. Indeed, as Atkin writes, "campaign messages that have the broadest reach can deliver only a superficial amount of information and persuasive content that is seldom customized to the individual recipient" (2001, p. 56). However, these programs can still be beneficial; they are typically inexpensive and can contribute to building awareness for important issues or projects (Atkin 2001, Jacobson 1999). Moreover, unidirectional activities, as demonstrated here, can positively influence citizens with low initial knowledge and a lack of formal opinions about these programs.

The second level of communication is more focused in scope and usually includes opportunities for interaction at the community or individual level.

Because such outreach activities target local priorities and specific environmental contexts, they will likely be more effective at influencing citizen understanding and acceptance (Brunson and Shindler 2004; McCaffrey 2004). Indeed, as citizen understanding of fire management becomes increasingly sophisticated, the flexibility of interactive activities to provide context-relevant information will become even more important. Of the factors that contributed to knowledge change in this study, the type of outreach experience was the only one that managers can directly control.

The take-home message from these case studies is that effective outreach goes beyond simply using standardized tools to provide information. As demonstrated here, outreach success is not only a result of the information provided but also the method of delivery. Indeed, "the availability of information does not necessarily mean that it will reach its audience or be effective once it gets there" (McCaffrey 2004, p. 12). Successful communication requires effective planning including consideration of the communication objective, the nature of the topic, and audience characteristics including prior knowledge and attitudes (Jacobson 1999). Fire and fuel management are resource issues that offer a real opportunity for achieving success through communication and outreach. The public has long looked to management professionals to provide sound information and leadership regarding fire issues (Shelby and Speaker 1990). As findings here suggest, managers can use this leadership role to influence public understanding and generate positive attitudes for management activities.

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Reduction of Potential Fire Behavior in Wildland-urban Interface Communities in Southern California: A Collaborative Approach

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Abstract—This manuscript details a collaborative effort that reduced the risk of wildfire in an affluent, wildland-urban interface community in southern California while simultaneously minimizing the environmental impact to the site. FARSITE simulations illustrated the potential threat to the community of Rancho Santa Fe in San Diego County, California, where multimillion-dollar homes were located immediately above a designated open space area that consisted primarily of 60-year-old, decadent chaparral. Post-treatment fire behavior simulations demonstrated the potential ability to moderate fire behavior.

Results of the fire behavior modeling led to a recognition for the need for fuels treatments by both homeowners and regulatory agencies that were originally adverse to any type of treatment. Through a collaborative process, these diverse stakeholders worked to create and maintain an effective fuel treatment that was cost effective and environmentally sound. This shared approach by fire personnel, homeowners, and regulatory agencies in Rancho Santa Fe is a success story that could be a template for interface communities throughout southern California.

Introduction

Nowhere in the United States is the increasing trend of destructive fires in the wildland-urban interface (WUI) better exemplified than in southern California. Coupled with a burgeoning population that continues to expand into explosive chaparral fuels, there is an ever-increasing potential for widespread destruction to human life and property. For example, eight fires in southern California have grown to over 100,000 acres in size, including the 2003 Cedar Fire in San Diego County, which burned over 273,000 acres (California Department of Forestry & Fire Protection 2005a). And in terms of structures lost, 14 of the 20 most destructive fires in California occurred there, again led by the Cedar Fire, which consumed 4847 structures (California Department of Forestry & Fire Protection 2005b).

To reduce the costs and losses associated with wildfires, fire agencies allocate their limited resources to two primary strategies in the WUI. The first strategy is to maximize success of initial attack by funding additional suppression equipment and personnel. Alternately, pre-fire fuels treatments are a second strategy meant to reduce fire behavior, thereby increasing suppression success and decreasing number of structures lost. While proven effective in numerous fire events, the second strategy is seemingly more difficult to implement due largely to sociopolitical factors such as perceived degradation of viewsheds and costly and timely navigation through environmental review.

Pre-fire fuels management is also more difficult to measure success as treatments are not necessarily meant to eliminate fire spread. For example, fuel treatments in the 2002 Rodeo-Chediski fires in Arizona significantly reduced fire intensity and rates of spread within the treatments, yet did little to impede spread across the landscape as the fire's path simply flanked the treatments and continued unabated (Finney and others 2005). In the WUI, success of fuels treatments may be measured by any number of metrics, including initial attack success, percentage of homes survival, and others. Additionally, other metrics of success could include the degree to which the treatments retained the positive benefits of vegetation such as scenic beauty, carbon sequestration, mitigation of heat island effect, stormwater retention capacity, and others (Dicus and Zimmerman in review).

For WUI areas in southern California, we broadly define a successful project as one that is

(1) completed on the ground,
(2) cost effective,
(3) environmentally sound, and
(4) effectively modifies fire behavior to an extent that minimizes structures consumed.

Based on the preceding metrics, a case study that examines the relative success of a fuel modification project in Rancho Santa Fe, California follows.

Community Overview

Rancho Santa Fe is an unincorporated community of 3,252 people (2000 U.S. Census) that is located approximately 20 miles north of San Diego, California (figure 1). The community is a classic example of a wildland-urban intermix, where homes are interspersed between designated open space parcels of mostly unmanaged vegetation. It has been designated by the State as a *Very High Fire Hazard Zone.*

The high value of homes in Rancho Santa Fe set it apart from most WUI communities. Data from the California Association of Realtors reveal that the median home price there exceeded $2.5 million in 2005. Further, as of the 2000 census, Rancho Santa Fe had the highest per capita income of any community in the United States with over 1000 households.

In the absence of Santa Ana winds, fuels will have the greatest effect on fire behavior and is subsequently the greatest threat to homes. Topography consists mostly of gently rolling slopes and drainages. Weather is Mediterranean and is greatly moderated by proximity to the Pacific Ocean. Property owners, by ordinance, must "maintain an effective fuel modification zone by removing, clearing, or thinning away combustible vegetation and other flammable materials from areas within 100 feet of any structure" (Rancho Santa Fe Fire Protection District Ordinance No. 02-01). It is the responsibility of individual property owners to create and maintain this buffer. However, if the 100 ft buffer around a structure exceeds the property line of a specific homeowner, it is the responsibility of the adjacent landowner to manage vegetation on his own property so as to maintain the 100 ft buffer for all structures. In many instances in Rancho Santa Fe, the 100 ft buffer from structures extends into adjacent open space parcels.

Fuels in the interspersed open space parcels consist largely of decadent, highly volatile brush that has not burned in over 60 years. Vegetation in the

Figure 1—Location of Santa Rancho Fe, San Diego County, California.

open space areas is typical of southern California chaparral, consisting of such native species as scrub oak (*Quercus berbidifolia*) and chamise (*Adenostoma fasciculatum*). Further, exotics such as red gum eucalyptus (*Eucalyptus camaldulensis*) and pampas grass (*Cortaderia jubata*) are commonly found there.

The open space areas are the responsibility of the Rancho Santa Fe Association (hereafter, Association), a homeowners association that administers a protective covenant of land use rules in the area. All members of the Association are responsible for paying for the maintenance of the open space parcels, regardless if individual property owners are directly affected. The only vegetation management in these areas had been to periodically cut the brush along horse trails that crossed through the middle of the open space areas, which would have minimal effect on the spread of wildfire.

Structural and wildland fire protection is provided by the Rancho Santa Fe Fire Protection District (hereafter District), which serves a 42-square mile area surrounding Rancho Santa Fe. The District, however, is in a designated State Responsibility Area for wildland fire protection, and is thus also served by the California Department of Forestry and Fire Protection. This designation served to facilitate the fuels treatments that will be discussed later.

Of note, the District has adopted a shelter-in-place approach for residents of some newer subdivisions during a wildfire because homes there have been built with extremely fire-resistant construction materials and have District-approved landscaping. The District contends that sheltering in the fire-resistant structures during a wildfire would be safer than attempting to evacuate along winding roads adjacent to potentially burning vegetation.

The older, previously developed community of Rancho Santa Fe, however, is not as fire resistant as the newer developments. Commonly, private residences sit atop ridges above the aforementioned open spaces and would receive immense convective heating from burning of the explosive chaparral fuels. Further, several of the residences still have wood shake roofs, which have been shown to be especially susceptible to combustion from burning embers (Cohen 2000). Thus, even with a 100 ft managed buffer around structures, risk to many residences remains high.

Project Implementation

One particular area in Rancho Santa Fe had long been a concern to the District. This area was in a chaparral-filled canyon with homes regularly located at the tops of the ridges in natural chimneys and saddles (figure 2). A formal risk assessment across the District confirmed that this area was at elevated risk of loss during a fire event. Given the pre-treatment conditions of the open space parcel in question, the District expected to lose a minimum of eight homes during a wildfire event.

Given the value of these homes and the historic behavior of wildfires in the area, members of the insurance industry were also extremely concerned with potential losses from wildfire. Because of their high replacement costs,


Figure 2—Aerial photograph of the El Secreto fuel modification project in relationship to homes in Rancho Santa Fe, California.

destruction of only a few homes in Rancho Santa Fe would cause a tremendous loss to the industry, translating into an increase in rates for not only San Diego County, but potentially for homeowners across southern California.

FARSITE simulations from a single, likely ignition point during historic 50% and 97% weather illustrate the pre-treatment potential fire behavior in the area (figures 3 and 4, respectively). Even with a 100 ft buffer around the homes, many would likely experience intense convective heating, if not direct flame impingement. Pertinent weather and fuel values for all simulations are provided in table 1 and were determined by FireFamilyPlus analysis of historic weather data from the nearby Flores RAWS station. A custom fuel model (fuel model 20) was utilized to simulate fire spread within the 100 ft buffer. Figures 3 to 5 depict extent of spread and flame length (ft) for a 1-hour simulation (5-minute visible time steps) where all inputs were held constant.

The District contacted the Association regarding unmanaged vegetation on the open space parcels that were within 100 ft of structures and provided suggestions for mitigation. The District did not take a heavy-handed approach with the Association, but instead sought an open dialogue with the Association so as to make them aware of the hazards and recommend solutions that were in the best interest of the community.

Modeling efforts were presented to members of the Association who, while not understanding the nuances of wildland fire behavior modeling, appreciated the potential for a significant fire event. Subsequent simulations that
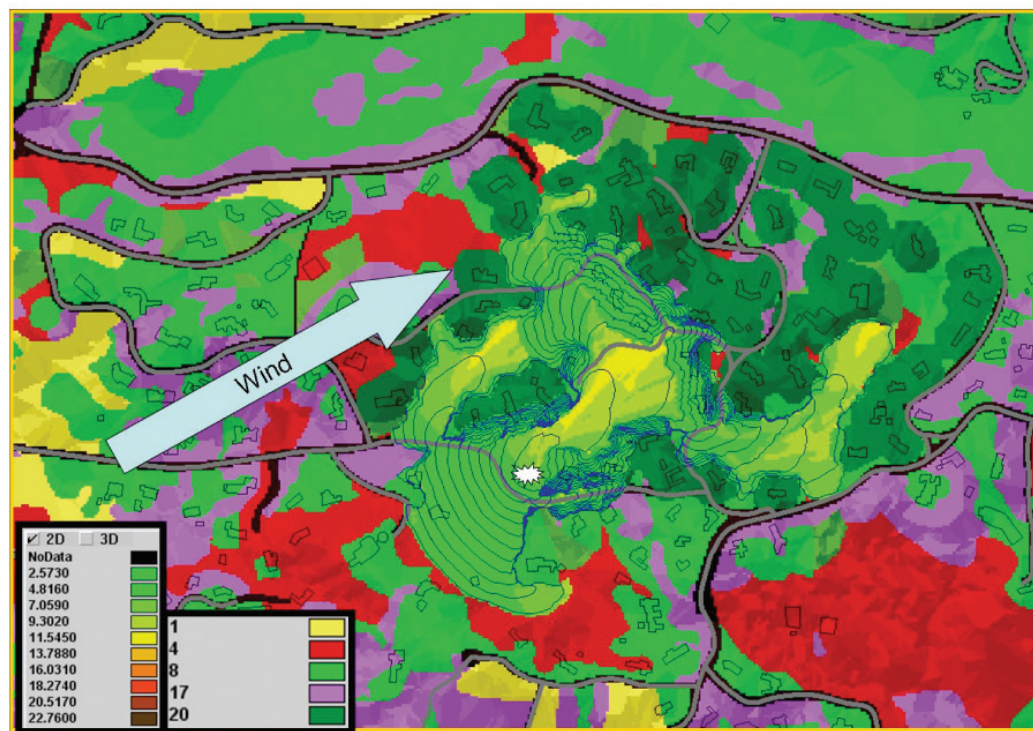
Figure 3—Pre-treatment FARSITE simulations from a single ignition point (in white) under 50th percentile weather and wind conditions (August). Flame length (ft), 5-minute time steps, and background fuel models are depicted.
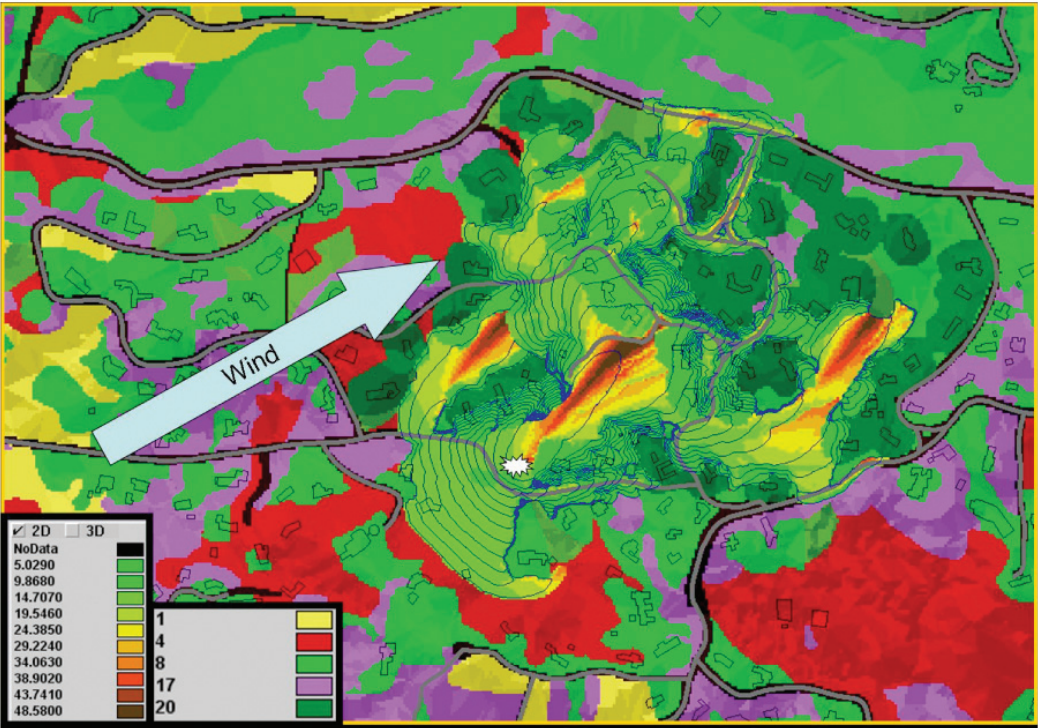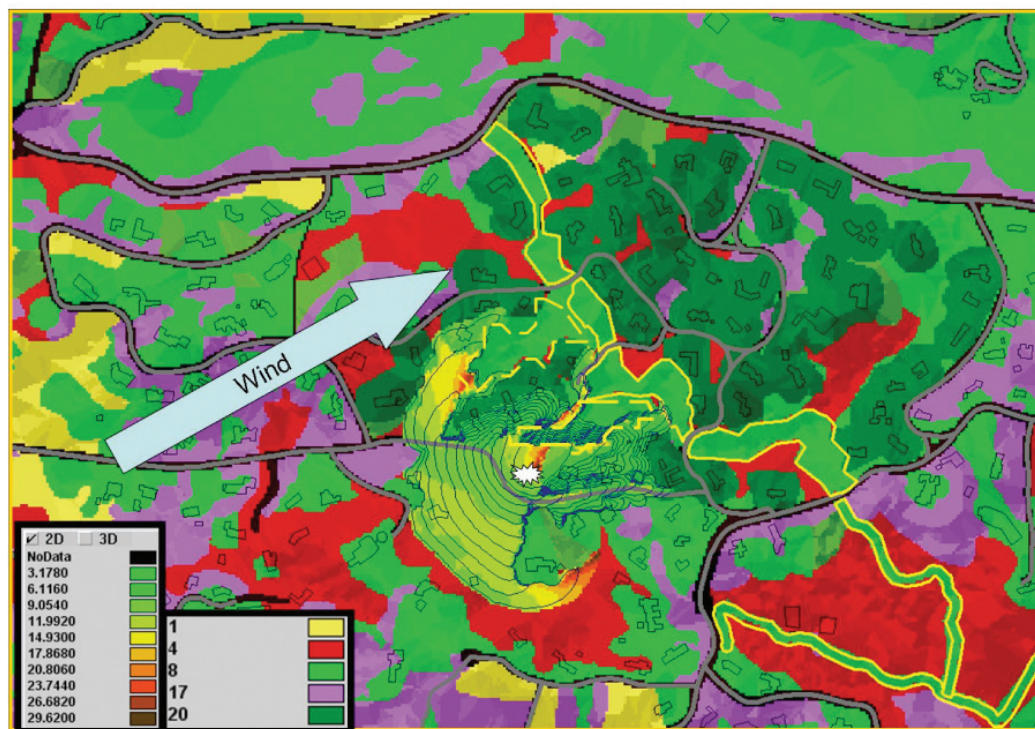
Figure 4—Pre-treatment FARSITE simulations from a single ignition point under 97th percentile weather and wind conditions (August).

Table 1—Average and extreme (August) weather, wind, and fuel moisture inputs used in FARSITE simulations in Rancho Santa Fe, California. Values obtained from FireFamilyPlus analysis of nearby Flores RAWS station.

| | Percentile | |
Variable	50th	97th
Max Temp[1]	76	85
Min RH[2]	22	13
Wind Speed[3]	10	20
1-hr FM[2]	6	3
10-hr FM[2]	8	5
100-hr FM[2]	10	7
Herbaceous FM[2]	60	30
Live Woody FM[2]	80	60

[1] °F
[2] Percent
[3] mph

Figure 5—Post-treatment FARSITE simulations from a single ignition point under 97th percentile weather and wind conditions (August).

accounted for a fuels treatment in the area (conversion to fuel model 8) clearly illustrated the potential benefits of those treatments to adjacent landowners, even under 97% weather conditions (figure 5). The District explained to the Association that any fuels treatment would not stop a wildfire, but would reduce the fire intensity, thereby reducing the threat to nearby structures and increasing chance of initial attack success. The Association Board of Directors created and distributed a simple but compelling brochure to their members that detailed the need to allocate funds for the project as it would benefit all members of the Association, not only the homeowners adjacent to the proposed fuel modification.

The Association was initially somewhat hesitant to initiate fuels modifications in these areas based not on perceived degradation of views or environmental impacts, but instead on the potential cost of treatments. Indeed, initial estimates from contractors on the 11.26 acre (4.65 ha) El Secreto project ranged from $65,000 to over $200,000. District personnel worked with the Association to explore other, more economically feasible options.

The District sought assistance from publicly funded crews because the project area was within a designated State Responsibility Area for fire protection and was by law, technically open to the public (even though the Association attempts to discourage outside access as much as possible to the open space parcels). CDF-administered inmate crews were subsequently contacted. At first, the community members were extremely adverse to inmate crews in the community due to perceived safety concerns. Association Board Members visited the applicable correctional facilities to personally investigate the crews

and subsequently provided assurance to their members that the inmate crews would pose no threat to the neighborhoods. That assurance, in addition to the extremely low estimated cost of the implementing the project ($30,000), eventually won the community over.

After CDF contracts were established, the Association notified the California Department of Fish & Game (CFG) of their intent to carry out the fuels modification project per guidelines established in a preexisting Memorandum of Understanding between CFG, the U.S. Fish and Wildlife Service (USFW), CDF, the San Diego County Fire Chief's Association, and the Fire District's Association of San Diego County. The MOU states that after notice of intent to clear vegetation for fire protection purposes is given, CFG and USFW biologists have the option to review the project for compliance with endangered species requirements, and may suggest voluntary, alternative measures if deemed feasible and warranted. While the District was responsible for establishing the need and proposed mitigation measures in the project, they purposely did not write the notice of intent to CFG in an attempt to avoid any potential interagency political wrangling.

Because the proposed El Secreto project exceeded the 100 ft buffer established in the MOU, CFG and USFW regulators required additional review. Once again, FARSITE simulations were used to justify the extent of the project. After analyzing the simulations, they agreed to an on-site review of the project area. The on-site review confirmed to the regulators that a majority of the vegetation in the proposed project area was dead and that removal of these fuels would not negatively impact habitat there. The regulators required that no more than 50% of the vegetation be removed, which was unreasonable in some locations as over 80% of the existing vegetation was dead at that time. They further requested that all flammable exotic species such as eucalyptus and pampas grass be removed, by herbicides if necessary, which was beyond the original scope of the District but welcomed.

Upon approval by CFG and USFG regulators, female inmate crews from the local Rainbow Camp began the project, demonstrating both outdoor savvy and the care needed to properly treat the area. Of interest, while initially adverse to inmate crews, homeowners quickly became enamored by the female crews and tried to offer cookies and cakes to them, which was against CDF policy of limiting contact between inmates and private citizens. The Association, however, was able to regularly provide Subway sandwiches to the inmates, which apparently increased both their productivity and care on the project. At the completion of the project, CDF invoiced the Association for $14,000, well below early estimates that exceeded $200,000 and the $30,000 for which the Association had budgeted. These savings will pay for future maintenance costs on the project.

The project had minimal negative environmental impacts and served to provide many positive benefits to the community. Indeed, only dead material was harvested during the project, which was subsequently chipped and spread on existing horse trails. This simultaneously eliminated green waste from entering the landfill and also mitigated erosion on the trails. Exotic pampas grass was eliminated from the project area with herbicide, but will likely return via seeds from ornamental plants on properties above the project. Further, anecdotal evidence suggests that there are more wildlife species present on the site after the treatment, but this may be a function of increased visibility of the area, which was marred by the abundance of dead vegetation. At the conclusion of the project, a shaded fuel break resulted that simultaneously lowered fire risk while having minimal impacts to the positive benefits that vegetation provide such as stormwater retention, improved air quality, and

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carbon sequestration. Whereas before there was an almost impenetrable mass of dead brush, the site is now regularly used by the community as a location to recreate.

Lessons Learned

By the metrics set forth at the beginning of this manuscript, the El Secreto Project was a success. Owing to a collaborative effort between local and state fire agencies, homeowners, and environmental regulatory agencies, the project was implemented on the ground after much planning, was relatively cost effective, and was environmentally sound. The ultimate test of the success of the project will come in a future, inevitable wildfire.

While this project is extremely beneficial to the properties immediately adjacent to the fuels project, it will have minimal impact to the spread of fire across the landscape, especially during a Santa Ana wind event, due to its relatively small size. However, the original strategy of the project was to maximize initial attack success on a fire occurring in the open space parcel, not stop a major wildland fire.

District personnel cite that the key to this project was the development of partnerships and collaboration with property owners and regulatory agencies. The District was instrumental in initiating meaningful dialogue between fire personnel, Association members, and regulatory agencies, which was vital to the scope and completion of the project. Collaboration does not imply "educating" the homeowners and regulators to the needs and desires of the fire agencies, but rather is meaningful communication where all viewpoints are considered to best serve the community. They also conclude that it is critical to adequately plan an environmentally sound and justifiable project before regulators participate in an on-site review of a project.

While pleased in the success of the El Secreto project, concerns over future projects remain. One concern is the regular turnover of CFG and USFG regulators in the region. Historically, many regulators seemed adverse to any type of vegetation management until a trust relationship had been developed with District personnel. With regular turnover, the fostering of mutual trust between the agencies will be hindered. There are also concerns about any future needed projects that might lie within the jurisdiction of the California Coastal Commission as they have historically been adverse to most vegetative management projects, regardless of the potential threats or species involved. Indeed, they were the only party that refused to sign the original MOU discussed earlier.

Because of the success of this program, other local communities now regularly seek to contract with the inmate crews, which could potentially limit the District's ability to use them for future projects. It is hoped that the strong working relationship forged between CDF and the District as well as the relatively central location within the CDF responsibility area will insure Rancho Santa Fe has access to crews.

Also, the continued presence of wood roofs in the area is an immediate threat to the community, due to their susceptibility of combustion from fire brands. Of interest, a portion of the residents in this affluent community are asset-wealthy, but simply do not have the means to replace their roofs with fire resistant materials. These property owners consist primarily of retirees who purchased their home in the 1970s or earlier when home prices were significantly less; while their home equity has appreciated exponentially, they live

today on fixed incomes. A recent grant to FEMA for a cost-sharing program to replace fire-prone roofs remains pending. The grant would fund 70% of the costs of roof replacement, with a cap of $40,000 per residence.

There are also concerns about undeveloped lots adjacent to parcels with structures. As with the Association's open space parcels, those property owners are responsible for modifying vegetation within 100 ft of a structure, regardless if their individual property is developed or not. Property owners of the undeveloped lots, many living outside the state, have sometimes resisted the District's attempts to enforce the 100 ft buffer. While preferring a collaborative approach to generate solutions that mitigate the threat, the District is sometimes forced to send outside contractors to those sites, subsequently billing the noncompliant property owners for work completed there.

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Fire Management in the Inter Galatic Interface or 30 Years of Fire Management at Merritt Island National Wildlife Refuge/ Kennedy Space Center, Florida

Frederic W. Adrian

Abstract—*Prescribed burning is essential on Merritt Island National Wildlife Refuge. Not only is it needed to manage the volatile fuels, but also to manage the complex system of fire maintained habitats found here. Fire management on the Refuge presents unique challenges. In addition to the restraints to prescribed burning that are common to many prescribed burning programs, Refuge fire managers must also consider the special needs of an operational space port. By using an active program of education, demonstration and negotiation with the Space Center, the Refuge has been able to maintain a prescribed burning program that has reduced the detrimental effects of unwanted wildland fires when they occur.*

Introduction

Merritt Island National Wildlife Refuge (Refuge) is located on the east central coast of Florida in Brevard and Volusia Counties (figure 1). The majority of the Refuge is an overlay of the National Aeronautics and Space Administration's (NASA) John F. Kennedy Space Center (KSC). The U.S. Fish and Wildlife Service (Service) administers these lands and waters under an interagency agreement. This agreement gives the responsibility for land management activities for KSC's non-operational lands to the Service. Included in these management responsibilities are wildland fire suppression and prescribed burning. The Refuge also has agreements with Canaveral National Seashore (CNS) to assist with both prescribed burning and wildland fire suppression and with the Cape Canaveral Air Force Station (CCAFS) to assist in prescribed burning. Together, these four federal agencies manage over 180,000 acres of relatively undeveloped coastal barrier islands and lagoons.

This coastal ecosystem is quite diverse. Schmalzer and others (2002) list 803 native plants on the Refuge and adjoining federal lands, with, 38 taxa listed as endangered, threatened or of special concern by the State of Florida. This wide array of plant species has been grouped into 20 native wetland and upland vegetative communities (U. S. Fish and Wildlife Service 2006). The Refuge's habitats provides protection and management opportunities for 10 regularly occurring federally listed threatened and endangered wildlife species, as well as for 36 species of federal management concern and 47 wildlife and plant species listed by the State of Florida (Epstein and Blihovde 2006). In addition, over 300 species of migratory and resident birds, 30 species of mammals, and 71 species of reptile and amphibians have been recorded on the Refuge (Adrian and others 2006).

Merritt Island National Wildlife Refuge
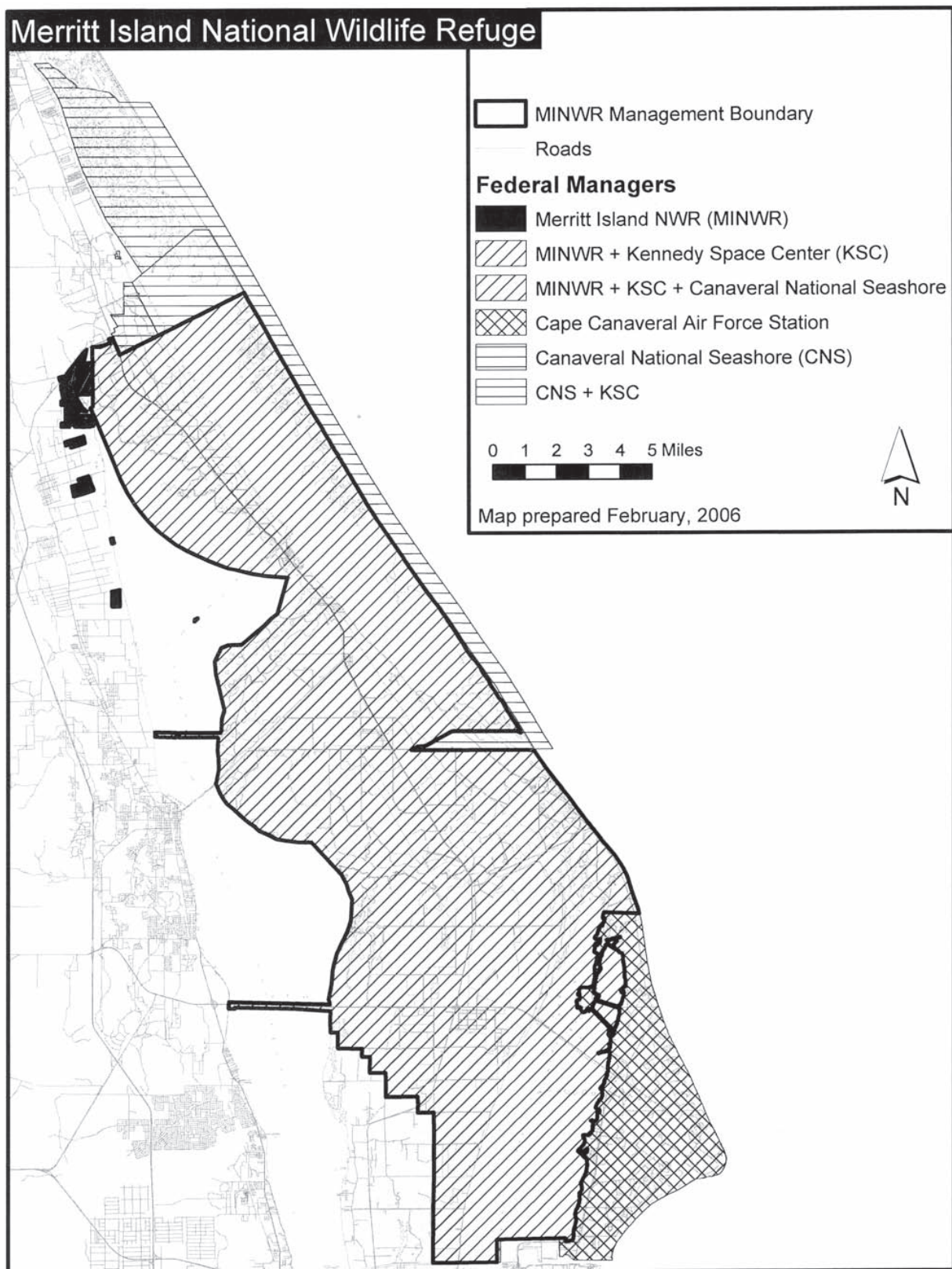
Figure 1—Location of Merritt Island National Wildlife Refuge and other federal agencies.

Fire History And Fire Ecology

Fire has been a component of the Florida ecosystem since before humans occupied the landscape. The National Weather Service Office in Melbourne, Florida states that Florida is the "lightning capital of the United States", with over 22,000 lightning strikes occurring in Brevard County alone each year (National Weather Service 2005). In historic times, lightning frequently ignited fires, which spread readily throughout the landscape. Examination of charcoal deposits in lake sediments show that fires have occurred in south central Florida for 50,000 years (Watts and Hansen 1988). It is logical to assume that fire has been instrumental in favoring the selection of fire-adapted traits in the Florida's vegetation.

Fire Maintained Vegetative Communities

Of the almost 77,000 acres of non-open water habitat on the Refuge, approximately 55,000 acres support plant communities that can be considered fire maintained. Without periodic fires, the characteristics of the four important fire-maintained vegetative communities on the Refuge described below would change drastically.

Oak Scrub: Oak scrub occurs on xeric sites. The shrub layer plants found here include sand live oak (*Quercus geminata*) myrtle oak *(Q. myrtifolia)* and Chapman's oak (*Q. chapmanii*) along with some palmetto (*Serenoa repens*). Occasionally, a sand pine (*Pinus clausa*) overstory is present. Historically oak scrub stands were low and open with many sandy patches.

The fire regime in the oak scrub can be described as intense and stand replacing. Oak scrub is difficult to ignite. In many cases, lightning fires started in more flammable areas, such as the flatwoods, and ran into the scrub areas. When ignited however, the oak scrub burns vigorously. Rates of spread are rapid and flame lengths of 40 to 50 feet were not uncommon. The natural fire return interval was between five and seven years. Stands of oak scrub regenerated quickly from root sprouting (Schmalzer 2003).

Scrubby Flatwoods: The scrubby flatwoods community is found on slightly wetter sites than the oak scrub. The shrub species found in the oak scrub are also found here, but palmetto is much more abundant. More mesic species such as gallberry (*Ilex glabra*) and *Lyonia* spp. are also present. In historic times a scattered overstory of south Florida slash pine (*P. elliottii* var. *densa*) was present. Both the oak scrub and the scrubby flatwoods are habitat for the federally threatened Florida scrub-jay (*Aphelocoma coerulescens*) and are the focus of a much of the Refuge's upland management activities.

Under natural fuel loadings, fires in the scrubby flatwoods were generally confined to the shrub layer, with overstory consuming fires only occurring during periods of extreme weather. Rates of spread were normally moderate as were the flame lengths. The fire return interval was between three and seven years. Most of the shrub layer vegetation regenerates from sprouting.

Pine and Palmetto Flatwoods: The pine and palmetto flatwoods community is found on the more mesic soils of the Refuge. The shrub layer is predominately palmetto with some gallberry, *Lyonia* spp. and wax myrtle (*Myrica cerifera*). Wire grass (*Aristida stricta* var. *beyrichiana*) is common. An overstory of south Florida slash pine is common, with some stands of pond pine (*P. serotina*) present in the wetter areas. Historically, fires kept the

understory low and open, and the overstory scattered to moderately dense. The pines in the flatwoods provide nesting habitat for the bald eagle (*Hali-aeetus leucocephalus*).

The historic fire regime in the flatwoods consisted of moderately intense fires that occurred every three to five years. The understory of the flatwoods burns vigorously and completely. Much of the vegetation is highly flammable. Species such as palmetto contain resins and oils which ease ignition and increase rates of spread. As was the case in the scrubby flatwoods, fires in the canopy were infrequent and occurred during periods of drought or when fuel loads became excessive.

Marshes: Both saltwater and freshwater marshes occur on the Refuge. The saltmarshes, the majority of which are now impounded, occur along the edges of the lagoon system on the Refuge. The native vegetation is primarily sand cordgrass (*Spartina bakerii*) a tall grass with some short grasses such as saltgrass (*Distichlis spicata*) mixed in. The freshwater marshes, or swales, also contain sand cordgrass along with some *Andropogon* spp. The swales are intermingled with the upland vegetation described above and are important in the flammability of those landscapes.

The historic fire regime was similar in both types of marshes. It can best be characterized as rapidly moving, intense fires with a fire return interval between two and four years. Fires usually consumed all of the vegetation and the stand was regenerated by sprouting (Schmalzer and others 1991). These frequent fires kept the stands of grass in an open condition. They also reduced the encroachment of woody species such as wax myrtle and salt bush (*Baccharius* spp.)

Human Fire Use

Evidence exists that Native Americans used fire extensively prior to the arrival of the first European explorers (Robbins and Myers 1992). The journals of many of the early explorers indicate that in the southeast, Native Americans used fire to clear fields and drive game as well as for communications and warfare. Many of these fires were set outside of the natural fire season.

The early European settlers used fire extensively for many reasons. Turpentine operations burned in winter, cattlemen burned in the spring and hunters burned in the fall. These activities, combined with the naturally ignited summer fires resulted in fire on the landscape throughout the year.

The past 50 years have seen controversy over the use of fire. Ranchers, timber companies, wildlife managers and others have continued to use fire, much of the time outside of the natural fire season. During the 1950s and 1960s there was a concerted effort to stop burning the landscape. In addition, efforts to suppress wildfires were increased. This was especially true at KSC.

Changes in the Ecosystem

The removal of fire from the ecosystem caused major changes in the landscape. Pine stands in the flatwoods and scrubby flatwoods communities became dense and overgrown. Mesic forests began to invade marshes where frequent fires once kept this encroachment in check (Duncan and others 1999). The oak scrub increased in height and density becoming difficult to ignite except under extreme fire weather conditions (Schmalzer and Adrian 2001).

These changes to the habitats affected the wildlife utilizing them. The thickness of the scrub vegetation made the oak scrub and scrubby flatwoods less suitable for the Florida scrub-jay and other scrub fauna. Unburned marsh grasses made movement difficult for secretive birds such as black rails (*Laterallus jamaicensis*). In some cases, brush in the marshes was thick enough to shade out grasses changing the habitat entirely.

Fuel loads increased in all of these vegetative communities. When fires did start, they burned with greater intensity than in the past. This was especially critical in the pine flatwoods. While historic fires tended to stay in the shrub layer, the increase in pine density resulting from the lack of fire increased the potential for crown fires. This removed nesting substrate for the bald eagle.

Refuge Fire Management

Early Fire Management

Fire management on the Refuge has changed considerably over the past three decades. Between the time the Refuge was created in 1963 and 1981 little active fire management was done. A review of the somewhat sketchy early Refuge records shows a few small prescribed burns, and occasional suppression activities. During this time, the responsibility for suppression of wildfires was confused with the Refuge taking action on some fires, and with KSC Fire (primarily a structural fire organization) suppressing others. Training of Refuge personnel was minimal and equipment was typically converted military vehicles and other used equipment.

Fuels Management Prescribed Burning

With little fire activity in the ecosystem, fuel accumulated to a point where it was only a matter of time before severe fires would occur. This happened in the summer of 1981 when 46 wildfires burned over 17,000 acres and two firefighters were killed. This calamity initiated the second phase of fire management on the Refuge. Training of wildland firefighters was increased, new equipment was purchased, and a contract helicopter was acquired for both fire suppression and prescribed burning.

An aggressive prescribed fire program was begun with fuels management as the primary objective. During this time period, burn units were large, with some up to 4,000 acres. Between 1982 and 1992 the Refuge had 108 prescribed burns totaling 121,743 acres with an average size of 1,127 acres.

Most units were designated using existing natural and man made-barriers. It was normal to find several different vegetation communities within a single burn unit. This meant that fire prescriptions could not be tailored to meet specific requirements for individual communities. This phase of the Refuge's prescribed burning did meet the overall objective of reducing the fire danger. In 1992, a year with similar weather conditions to 1981, the Refuge experienced 45 wildfires, but only 378 acres were burned and no injuries or fatalities were experienced.

Habitat Management Prescribed Burning

In the early 1990s fire management objectives began changing from simply reducing fuel loads to meeting wildlife and habitat management objectives. Beginning in 1993 the Refuge began to subdivide the larger units

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in an attempt to focus more on the burning requirements of the individual vegetative communities and the wildlife species they supported. Of primary importance was the maintenance and restoration of oak scrub habitat for the threatened Florida scrub-jay. Also of great interest was maintaining nesting substrate for the bald eagle in the flatwoods and managing habitat for black rails and other marsh birds in the grassy wetlands.

The size of the subdivided burn units was greatly reduced. Between 1993 and 2002 the Refuge had 202 prescribed burns totaling 93,402 acres in fire maintained habitats. The average burn size was 460 acres. Although some large burns are still conducted, especially in the marshes, it is expected that the trend for more burns covering smaller areas will continue. This is especially true as the Refuge continues to restore scrub habitat.

Space Exploration and Its Effect on Prescribed Burning

Many of the constraints and restrictions on prescribed burning on the Refuge are common to other fire programs. Concerns such as safety of firefighters and the public, increasing urbanization, fickle weather, staffing and funding shortages that are encountered on other stations are likewise present here. In addition to these considerations, this Refuge must deal with an active space port. While the Refuge fire program was evolving, the mission of the KSC was also changing. The Apollo and Saturn V programs were phased out in the late 1970s and the new Space Transportation System (STS) or Space Shuttle program was beginning.

At first, with limited launches and non-sensitive payloads, Shuttle operations had little impact on fire management operations. Burning was prohibited forty-eight hours prior to a scheduled launch and twenty-four hours prior to landing. Pre-launch concerns included danger while fueling the spacecraft, exposure of the orbiter to the elements and increased ground and air traffic just prior to launch. Pre-landing concerns revolved around smoke causing visibility problems in the Orbiter's glide path and anomalies (mishaps) during the landing itself. This soon changed. When KSC was determined to be the primary emergency landing site, rather than Edwards Air Force Base in California, burning was severely curtailed the entire time the Shuttle was in orbit. Although this was ten to fourteen days per space mission, with only two to three launches per year, sufficient burning could still be accomplished. However, as the number of launches increased, lost burning opportunities became substantial.

Additional constraints were established as plans progressed for the launch of the $2.2 billion Hubble Space Telescope (HST) in 1990. Original prescribed burning restrictions for the HST called for no burning within 25 miles of clean rooms where components of the telescope were being processed. This would shut down burning on the entire Refuge for the six to nine months of the Hubble's residency on the KSC. This situation did not bode well for the Refuge's fire management program. Especially since the HST was the first in a series of space-based observatories and other smoke sensitive spacecraft that were expected to be launched over the next fifteen years.

Along with restrictions on burning from space operations on KSC, the Refuge had to deal with CCAFS. At CCAFS, each different type of launch vehicle had its own set of managers, payload processors, and bureaucracy. Additionally, some of the payloads were military missions and much of the information about timing was secret. When it came to getting authorization to burn, almost anyone in either the KSC or CCAFS chain of command

could trigger a no-go for the fire. Refuge fire managers spent countless hours fielding phone calls, explaining the reasons for burning and begging to get permission to execute a burn.

The situation was quickly becoming untenable. There was a time when it appeared that all of the issues in force would reduce burning on the Refuge to a point where fire would no longer be a viable tool. It was obvious to all fire knowledgeable people that not burning would lead to a continued increase in the amount of very flammable vegetation. This would not only lead to a serious public safety problem from possible wildfires, but would also prevent effectively managing habitat for the numerous wildlife species found on the Refuge. Some way had to be found to provide for the integrity of both the space program's mission, and the purposes and objectives of the Refuge.

Conflict Resolution

The first step in the resolution process was to educate all of the concerned parties about the reasons for burning. The best selling point was the possible impact of severe wildfires that would occur if the vegetation on the Refuge/KSC was not burned on a regular basis. Here we had some help from Mother Nature. While the memory of the fires of 1981 were still vivid, burn approvals were relatively easy to obtain. As institutional memory faded, approval became more difficult. Florida's bad fire season in 1998 refreshed NASA's collective memory when fires shut down operations for almost a week. This situation precipitated much discussion as to how find more windows of opportunity for burning.

The second factor that helped sell the importance of burning was the Endangered Species Act. The Florida Scrub-jay Recovery Plan identifies the Refuge as having one of the four Primary Core Recovery Units (PCRU) for the threatened Florida scrub-jay (U. S. Fish and Wildlife Service, 2003). In the early 1990s jays were discovered on the site where the Space Station Processing Facility was to be constructed. As part of mitigation for continued use of this and other areas in scrub-jay habitat, NASA agreed to assist the Refuge in restoring overgrown scrub (Schmalzer and others 1994). Since burning is a critical component of scrub restoration, this compelled the KSC to work more aggressively to find windows for burning.

Along with establishing the need for burning, it was also necessary to demonstrate a level of competence in fire management activities. Although the vast majority of prescribed burns nationwide are executed with minimal impact to the surrounding areas, the small percentage of burns that do cause problems are well documented by the media. This situation can cause concern to neighbors when the Refuge announced that a burn is forthcoming. We in the fire community are well aware of the amount of planning, training and skill required to carry out a successful prescribed burn. In many cases however, those we deal with outside our community are not. In most situations, knowledge helps combat the fear of the unknown. This proved to be the case when dealing with NASA managers.

The importance of good communication in solving the problems between space operations and Refuge fire activities cannot be over emphasized. To ensure proper information flow, meetings were set up with all interested parties. In addition to stressing the needs for an active prescribed burning program, a presentation on the behind the scenes work that goes on was given. The extensive training given to burn bosses, firing specialists, air operations staff and other key fire personnel was detailed. The prescription development

process, including smoke screening, environmental parameters, equipment and staffing needs were explained. It was also pointed out that the Service requires that a qualified burn boss of appropriate skill level from outside the Refuge review the prescription. At the same time, NASA managers had a chance to express their concerns, ask specific questions concerning fire operations and, most importantly, meet Refuge fire managers face to face.

To further establish our credentials, key NASA managers were invited to observe burns. They were given the whole burn day experience, from the crew briefing to the critique at the end of the day. The overall result of these discussions and observations was an improved level of confidence in the Refuge's ability to conduct a successful burn. It was also important not to hide anything. All of us that have done any burns know that things can go wrong that are beyond our control. The most notable problem is fickle weather. NASA recognized the need for them to be able to initiate emergency protection measures for sensitive areas, such as clean rooms, should this occur.

Once the importance of burning was established, restrictions negotiated down to an agreeable level and comfort levels established, the final piece of the puzzle was to formulate a comprehensive burn notification process. The Space Center's dispatching office agreed to be the focal point for this endeavor through its Joint Base Operations Support Contract (JBOSC) Duty Office. In its early stages the Duty Office received the Refuge's request to execute a burn, and then notified telephonically a long list of interested parties. Not only was this time consuming, but there was still the problem of almost anyone being able to trigger a no-go situation. Over the years this system was improved. Through negotiations with NASA Test Director (NTD), Payload Processing, the Center Director and the Commander of the Air Force Station, this list of people that could actually cancel a burn was reduced to less than ten. All others on the notification list were only provided information. Any concerns had to be forwarded to one of the decision makers. The Duty Office also fielded most of the questions concerning the burn and only passed on to Refuge fire managers those calls they could not handle. The final step was to send all correspondence electronically.

Compromises Achieved

The process of education and confidence building resulted in a compromise that was acceptable to all parties. NASA managers recognized that burning is an essential part of managing the vegetation types that exist on the Refuge/Space Center. They also realized that no burning would eventually result in unacceptable impacts on both the space program and the environment. On the other side, Refuge fire managers became more aware of the sensitivity of spacecraft to smoke and the possible economic and scientific impacts should damage occur to these craft. Both parties recognized the need for compromise and communication.

Through negotiation, the original 25 mile radius burn prohibition when sensitive payloads were present was reduced to a more manageable six miles. Burns were allowed while the Orbiter was in space so long as all its systems were "nominal" and Edwards Air Force Base was available for emergency landings. Lines of communication helped find times in payload processing streams where burning could be done with minimum risk to space craft. Refuge and NASA managers meet several times a year to discuss upcoming operations on both sides that may come into conflict.

A Measurement of Success

The real question is: Did all this effort to find ways of maintaining a pre-scribed burning program in the middle of an operational space port have any measurable results? One way to quantify the results is to determine if the effects of wildfire events in years similar to 1981 were in any way less catastrophic. In 1981, there were 40 wildfires burned a total of 19,335 acres. Four fires were over 1,000 acres in size, with the largest being 6,300 acres. The average fire size was 483.8 acres. There were also two fatalities. When 1981 is compared to several subsequent severe wildfire seasons, one can see a considerable difference in acres burned and average fire size as shown in table 1.

The first of these seasons occurred in 1992. Several years of below nor-mal rainfall preceded this fire season, as was the case in 1981. Forty-eight wildfires were ignited during the spring and summer. However, only 1,404 acres were burned, most of this was in one 1,200 acre fire which occurred when resources were spread thin on a day when several fires were started. The average fire size was 29.7 acres. There were no injuries to firefighters or other personnel, nor were any structures damaged.

Another bad fire season occurred six years later in 1998, when 25 wildfires burned 5,555 acres. As in 1992, multiple starts exceeded initial attack capa-bilities and several fires burned together to account for 4,090 acres of this total. The average fire size was 222.2 acres. While this is much larger than the average size in 1992, it is still less than half of what was experienced in 1981. Again no injuries occurred and no structures were damaged.

The drought that began in 1998 continued through 1999 and 2000. In 1999, 16 fires burned a total of 1,219 acres. Once again, one large fire that burned 1,084 acres. The average fire size this year was 76.2 acres. No injuries resulted and no structure damage occurred. By 2000, the drought had abated somewhat. More thunderstorms resulted in 25 starts a third again more than the previous year. This year only 319 acres were burned, with the biggest fire only amounting to 150 acres. No injuries or structure damage resulted.

The Refuge burns between 15,000 and 20,000 acres in a normal year. Even in these strenuous wildfire seasons a number of prescribed burns were completed. It is difficult to determine how much of this reduction in acreage burned should be attributed to the fuels reduction resulting from prescribed burning. Training of personnel and improved equipment certainly played a role. However, without the consistent application of prescribed fire to the Refuge's landscape, more acreage would have been burned by unwanted wildland fire in 1992 and the years of 1998 through 2000. More impor-tantly, the risk to Refuge firefighters suppressing of these fires would have been greater.

Table 1—Comparison of severe fire years at Merritt Island National Wildlife Refuge.

Year	Number WF	Acres burned	Av. Fire size	Largest fire	Number Rx fires	Acres burned
1981	40	19,335	483.8	6,300[a]	2	3,690
1992	48	1,404	29.7	1,200	8	7,552
1998	25	5,555	222.2	4,090	20	5,605
1999	16	1,219	76.2	1,084	19	2,380
2000	24	319	13.3	150	25	7,414

[a] Four fires were over 1,000 acres.

Conclusions

Carrying out an prescribed fire program on Merritt Island National Wildlife Refuge presents some unique challenges. The dialogue between Refuge fire managers and the various components of the Nation's space program is an ongoing process. As the space program changes, new points of conflict will arise and new ways to meet the objectives of all the agencies involved must be developed.

Managing fire at Merritt Island National Wildlife Refuge has many unique aspects, but many of the conflict resolution processes described here are applicable in other places. Certainly talking with neighbors and other concerned parties is necessary to sell a burning program. It is likewise important for fire managers to learn the specific concerns of those who live and work in the vicinity of burns. Establishment of communication channels through homeowner associations, the media and personal contact is essential to obtaining the support of the community for a burning program. Allow the public to see the degree of professionalism that is a part of the burning activities.

It is also important to be honest. No amount of planning, no amount of training nor the best forecast in the world can guarantee that nothing will go wrong. However, up front discussions of this possibility and the presence of a good contingency plan can go far in mitigating a bad situation should it occur. Remember, use discretion and care. History has shown that one mishap can undo years of successful confidence building. In spite of all this, the experience of the Refuge's fire program shows that, with perseverance, and initiative, an effective prescribed burning program can be developed under difficult circumstances.

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Measuring Success in Your Fuels Program: From the Report Card to Valuable Learning

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Abstract—*How can a unit learn in everyday fuels programs and from program reviews? How can a unit move from living in the "report card" culture to discovering more effective ways to improve what it knows and how it learns? Six specific tasks are critical to organizational learning according to David A. Garvin of Harvard Business School. By engaging in these tasks a unit can significantly improve both its programs and its learning. To further assist field units, an organizational learning survey has been recently developed by the Harvard Business School in cooperation with the Lessons Learned Center. This tool is designed to measure how a unit learns. By examining the learning environment, learning processes and leadership one can measure a unit's level of learning and its improvements over time.*

Introduction

Fuels programs around the country are faced with their programs being evaluated in periodic program reviews. These reviews often follow a report card format rather than a true learning format. This paper is aimed at two audiences: fuels programs at the unit level and those who serve on program review teams. Unit level fuels programs who take the time to practice the six critical tasks of a learning organization and periodically take the learning survey should find they are better prepared for program reviews. Program reviewers who incorporate the six critical tasks into their reviews and then share the unit lessons and effective practices will improve the wildland fire organizational learning environment.

Critical Tasks in Fuels Programs

According to Garvin, a learning organization tries to accomplish six tasks:

1. Collect intelligence about the environment.
2. Learn from the best practices of other organizations.
3. Learn from its own experiences and past history.
4. Experiment with new approaches.
5. Encourage systematic problem solving.
6. Transfer knowledge throughout the organization.

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These six critical tasks can be directly applied in wildland fire fuels programs:

1) In *continually collecting intelligence about the fuels environment*, make certain to collect critical information and regularly incorporate it into your planning and implementation. Search, inquiry and observation are the three methods for collecting intelligence. When searching, use comparisons and remember to cross-check to validate the accuracy of the information. When using the inquiry method, be exploratory by asking open-ended questions. Observation is particularly important when a lot of the tacit knowledge at a unit is in individuals' heads. If "we know more than we can tell" than the observation method is particularly effective in program reviews. Although program reviews generally take place in the off season, everyone can learn more effectively if a review is done during a prescribed fire or wildland fire use event because lessons and effective practices can be more clearly illustrated.

2) *Learn from the best practices of other organizations by* looking at successful processes other fuels or fire management programs are using and see how they may be applied in your unit. One way to do this is through the Wildland Fire Lessons Learned Center's myfirecommunity.net Web site which serves as an online community center for the interagency wildland fire community. The member directory identifies current projects on which individuals are working, particularly in fuels. The neighborhoods are specifically designed for communities of practice (networks of people) to share knowledge about their fire management programs.

Lessons Learned Center Information Collection Team reports (ICT) are another way to learn about the effective practices of other fuels organizations. Two recent ICTs have focused on wildland fire use (WFU) programs both from a unit that had its first WFU to a unit with a 35 year history. Both of these reports are at: http://www.wildfirelessons.net/ICT.aspx

3) *Learn from your own experiences and past history* by continually examining your unit's past performance. Use the After Action Review (AAR) process to learn from each project whether it be a mechanical fuels treatment, prescribed burn, or WFU. The four questions in an AAR are: 1) What was the plan? 2) What actually happened? 3) Why was there a difference? and 4) What are we going to do next time? (sustain/improve) To properly use the AAR process, it is imperative to take the answers to the fourth question and incorporate what will be sustained and improved into short and long-term planning. Units that successfully do this actually assign individuals to be responsible for incorporating the recommendations into the fuels program planning process.

4) *Experiment with new approaches* that you learn from other fuels programs or come from your unit AAR process. Try a different approach especially if what you have been doing has not been working the way you want. It is extremely important to listen to unit members who have a different perspective and be open to adopting a new idea.

5) *Encourage systematic problem solving* among all members of your unit. Follow a systematic path while trying to solve a problem by looking at what was planned, what happened, and *why* it happened. It is common to try and correct a problem without analyzing what happened and why.

6) *Transferring knowledge throughout the organization* is the true test of being a learning organization. Make sure you set aside time during planning and information meetings to share new knowledge with your fuels and fire

management staff as well as other units. The Lessons Learned Center is your resource center for sharing what you have learned beyond the scope of your own unit. The AAR Rollup is the format for units to record and share their lessons and effective practices. The Rollup captures the successes, challenges, training curriculum and unresolved issues recommendations. Individual units and program reviewers should submit these to the Lessons Learned Center. The AAR Rollup form can be found at: http://www.wildfirelessons. net/AAR.aspx

Organizational Learning Survey

The Lessons Learned Center has been cooperating with Harvard Business School as they developed the first of its kind organizational learning survey to help individuals and units measure their strengths and weaknesses in relation to the six critical tasks of organizational learning. During the summer of 2005, approximately 200 interagency wildland fire personnel took the draft survey online. Members of the wildland fire community completed it as an individual working unit, a wildland firefighting crew, or as an incident management team member. Initial results illustrated that the wildland fire community rated well in the sections compared with three other organizations that completed the survey.

The survey tool has three sections:

1) Learning culture and environment – this includes the interpersonal climate, how differences are valued and the openness to new ideas.
2) Learning Processes – six processes assessed are experimentation, information collection, analysis, education, training and information transfer.
3) Leadership – eight different aspects of how managers communicate and relate to employees are evaluated.

The survey tool is in its final completion stages and should be online for the wildland fire community and other organizations to use in May 2006. Individuals will be able to take the survey and have their scores measured against others in the wildland fire community. From the survey scores, individuals and units can see what areas they are strong or what areas need work. Units can then take the survey periodically to further improve their fuels programs.

Conclusion

Units can continually improve the learning environment of their fuels program by using the six critical tasks of a learning organization. Program reviewers can move away from a report card format by incorporating the six critical tasks into their reviews. Fuels programs and program reviewers should share the knowledge with the Lessons Learned Center so others in the wildland fire community can also learn from them. The organizational learning survey will also assist fuels organizations in measuring their effectiveness as a learning organization in comparison with others in the wildland fire community.

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